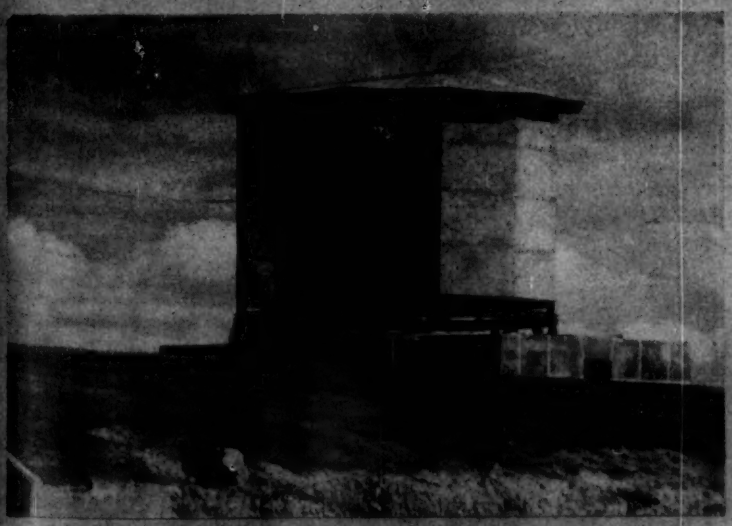
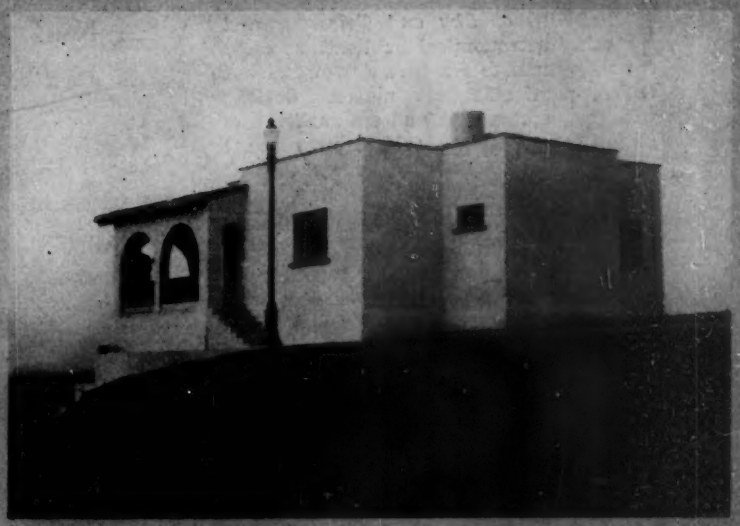
Sky and TELESCOPE

MAR 27 1942





The principal buildings at Tonanzintla Observatory

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Vol. I, No. 6
APRIL, 1942
20 Cents

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An Amateur Looks at Mars
The Era of Nabonassar
Clouds
Astronomy at the Inter-American Scientific Conference
The Starry Heavens in April

The Editors Note . . .

"CLOUDS ECLIPSE ECLIPSE"

THOUGH the New York *Herald Tribune* headlined as above its report of the frustrations met by amateur astronomers in the northeastern United States in observing the total lunar eclipse on March 2nd, its story of the unseen eclipse was three quarters of a column long. A dozen newspapers in New York and vicinity gave space to the occasion; and seven newspaper men were on hand at Westbury, where the New York observers gathered.

Evidently, even an astronomical failure is valuable as "relief" from more vital problems. This is certainly true for the amateurs preparing and participating in any "expedition," and also, in less measure, for the general public.

Members of the New York Amateur Astronomers Association, led by George V. Plachy, secretary, and Peter A. Leavens, chief photographer, set up a battery of cameras, cinecameras, and telescopes, in the potato field of Joseph Schneider, at Westbury, L. I., only to have their preparations go for naught. About 25 members of the society gathered at the appointed hour, but they "took a few pictures of each other and stood around disconsolately," according to the *Herald Tribune*.

In many places the clouds were thick throughout the evening, while at others the late partial phases were seen through a misty veil.

READERS of *Sky and Telescope* and other astronomical publications often see references to Harvard Announcement Cards, particularly in matters dealing with new discoveries and announcements in the astronomical world. However, not all of our readers may be aware that these cards are available to any interested person, and that by their use an amateur astronomer may turn his telescope to a new comet, asteroid, or star, nearly as promptly as the professionals themselves.

The Harvard Announcement Cards report all types of observations requiring prompt attention, and include such discoveries by European, African, and Asiatic astronomers as are reported by radio or cable from the Copenhagen Observatory, clearinghouse in Europe. Approximately 40 cards are published each year, printed on penny postcards. Subscribers pay one dollar for 25 cards, $3.75 for 100 cards; address Announcement Cards, Harvard College Observatory, Cambridge, Mass.

Recent titles of cards include: Comet 1942a; Red Star; Comet Schwassman-Wachmann; Comet Van Gent; Jupiter VIII; New White Dwarf; Z Andromedae; Jupiter X; Occultation Observations.

Sky and TELESCOPE

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In Focus

ACCORDING to Leland S. Copeland, who reports some of the story of the Seven Sisters in his department this month, "Time exposures disclose that most of the Pleiads are surrounded by nebulous material, especially Merope and Maia, so it is really true that Merope covered her face."

The back-cover photograph reveals wispy clouds surrounding: Alcyone (*center*), Merope (*upper right*), and Maia (*upper left*), which with Electra (*upper center*) form the bowl of the Pleiades' "dipper." Streaks of nebulosity run vertically (west and east), looking almost like defects in the reproduction. The peculiar patterns around each star are caused by diffraction past the secondary.

Atlas (*lower center*) and its companion, Pleione, form the end of the dipper's handle. Yerkes astronomers report that Pleione exhibits the most conspicuous shell spectrum ever observed in any star not known to be a nova or a nova-like object. At the Mexican conference, Dr. Otto Struve described exceedingly rapid rotation for some stars (seven hours for Altair), including, in particular, the Pleiades. He suggests that Pleione's shell may be the result of a partial breakup caused by its rapid rotation.

As a corollary, the Pleiads near the center of the cluster seem to rotate faster than those near its edge, which may indicate that the rapid rotation is caused by the nebulosity, which is of the "reflection" type—its spectrum similar to that of the associated *B*-type Pleiads. This indicates that the nebulous material consists chiefly of dust particles, so Dr. Struve's suggestion fits closely with Dr. Fred L. Whipple's discussion of the possible formation of stars out of interstellar dust clouds.

The Pleiades are about 100 parsecs (325 light-years) distant. Plates taken by Rutherfurd in 1868-1874 compared with those by Titus recently reveal 0.6 km./sec. as the mean internal space velocity of the 26 brightest Pleiads. This indicates a total of 260 solar masses, of which Hertzsprung accounts for about 200 among observed members. The remainder apparently consists of very faint stars and the nebulosity.

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COVER: The principal buildings at Tonanzintla Observatory, photographed by Dr. Donald H. Menzel. **Upper left:** The administration building, containing the lecture room and library. **Upper right:** Building housing an auxiliary telescope—and one of the region's few trees. **Lower left:** The dome of the new Schmidt, not quite complete. The entire building revolves. **Lower right:** The attractive lodge for the visiting astronomer.

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BACK COVER: The Pleiades, photographed with the 36-inch Crossley reflector at Lick Observatory, by H. W. Babcock. Exposure, two hours, with full aperture, January 13, 1939. West is at the top, and the scale of the engraving is about one millimeter to 20.1 seconds of arc.

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Entered as second class matter, April 28, 1939, at the Post Office, New Rochelle, N. Y., under Act of March 3, 1879.

American astronomers make good sightseers; here some of them gather beneath the banner of welcome in the town of Tiripetio. All photos in this article by the author.

SOJOURN IN MEXICO

By Donald H. Menzel
Harvard College Observatory

On the morning of Tuesday, February 17th, President Manuel Avila Camacho of Mexico formally dedicated Mexico's new national astrophysical observatory at Tonanzintla in the state of Puebla. Under clear Mexican skies, and with the famous peaks of Popocatepetl and Ixtaccihuatl looming on the horizon, 27 astronomers, physicists, and geologists from the United States and Canada met with many Latin-American representatives to celebrate the important occasion. The Mexican dignitaries included, besides the president, the former president, Gen. Abelardo Rodriguez, Governor Dr. Gonzalo Bautista of Puebla, members of the presidential cabinet, the presidents of the supreme judicial and legislative bodies, the rectors of the universities of Mexico, and representatives of the Mexican scientific societies. About 10,000 Mexicans, some from great distances, came to witness the ceremonies: soldiers, business men, students, peasants.

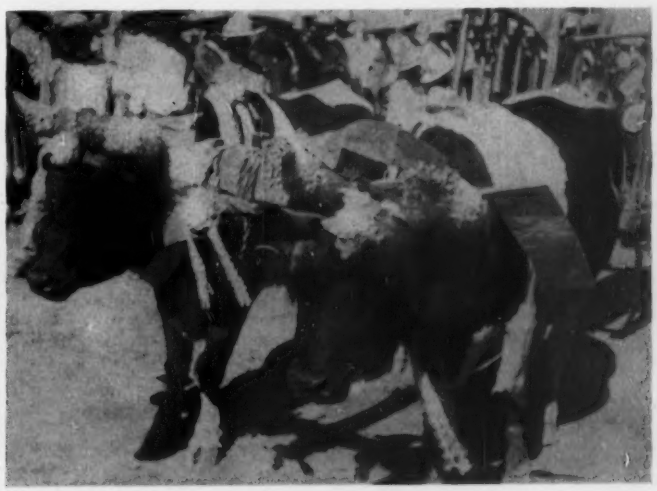
President Camacho unveiled the memorial tablet, and Governor Bautista, in his dedicatory address, stressed the importance of a hemispheric unity in all fields from defense to education and pure research. The governor's words made clear the stand that Mexico has taken, beside the United States, against the forces of aggression. His plea was for cooperation, based on mutual friendship and understanding.

Dr. George Z. Dimitroff, of Harvard, for the benefit of the Mexican officials, then described and demonstrated the new telescopic equipment. The major instrument of the new observatory is a 27-31-inch Schmidt telescope,[1] constructed in the United States. (See *Sky and Telescope*, December, 1941, "Mexico's New National Observatory.") In spite of the war difficulties, six months saw the entire construction of the telescope. The Perkin-Elmer Corporation, of Glenbrook, Conn., made the optical parts. Their chief optician, Halley Mogey, is responsible for the perfection and high precision of the optical surfaces. The optics have been so designed that star images of uniformly excellent quality will appear anywhere over the 8-inch-square photographic plate. The telescope mounting was designed and constructed under the direction of Dr. Dimitroff in the shops of Harvard College Observatory. The mechanical work was supervised by E. A. Guertin and Walter A. Locke.

The new national observatory is located on land provided by the government of the state of Puebla, near a small town of Aztec origin, called Tonanzintla, which lies about 80 miles east of Mexico City. Dr. Luis Enrique Erro, the director, plans to make special studies of the Milky Way. Since the latitude of the observatory is +19°, some of the rich southern sky, inaccessible to observations by instruments farther north, is strategically placed for study. The climate is excellent, especially during the winter. The program of the new observatory also calls for studies of variable stars, meteors, and the sun.

On the afternoon of February 17th, President Camacho formally opened the Inter-American Scientific Conference, which lasted for the following week, with sessions held at Tonanzintla, the University of Puebla, and the University of

[1] ED. NOTE: It has been found that the telescope, reported as a 24-30-inch by Dr. Bok in December, can be effectively used over the complete sizes of the components—hence, the instrument has been mounted as a 27-31-inch.



At Mil Cumbres, pretty marimbaphone players furnished entertainment for the visiting scientists, while at Tiripetio even the oxen drawing carts were decorated.

The old and the new. At left is a portion of the University of Michoacan, oldest in America (16th century), with which the new Tonanzintla Observatory main building contrasts strongly.

Mexico, in Mexico City. Dr. Harlow Shapley, speaking in behalf of the American scientists, reminded the assembled guests, and particularly the president, that his act in establishing a national observatory was similar to that of other enlightened rulers in history. He referred specifically to the cases of Greenwich and Poulkovo Observatories. Prof. Manuel F. Vallarta, distinguished Mexican scientist, whose work at the Massachusetts Institute of Technology on the subject of cosmic rays is well known, spoke for the Mexican group.

Throughout the conference, one felt the sincerity of the words of President Camacho, who said, in his invitation to the scientists, "The purpose of the Mexican government is to contribute to the maintenance, in the American continent, of the progress of science and culture, and thus counteract as much as possible the paralysis of scientific and cultural activities in the countries devastated by war."

There is no question but that the conference was among the most important in the history of science. Its value, measured solely by the large number of new advances and discoveries reported for the first time, was unquestionably great. The international situation, however, laid a dramatic setting that deepened the significance of the congress. The association, both formal and informal, among the scientists of the respective countries, served to strengthen the ties of friendship between the United States and Mexico in one of the most critical periods of all time. "Friendship" is almost too neutral a word; "fellowship" perhaps expresses a little more clearly the spirit of the meetings.

The first evening, before the assembled scientists and the Mexican officials, and more than 3,000 of the citizens of the town of Puebla, Dr. Robert R. McMath presented an address, illustrated with motion pictures of the planets and of solar activity taken at the McMath-Hulbert Observatory. So well received were the presentation and the pictures, that Dr. McMath was called upon to give a second showing a week later in the Workers University in Mexico City.

Throughout the conference, the papers were presented in both English and Spanish, with Drs. Carlos Graef and Alfredo Banos as interpreters. Several of the Americans and the majority of the Mexican participants made their own translations. Lively and often heated discussions followed the presentation of most of the papers. A surprisingly large number of topics centered on the theme of the structure and evolution of the stars and of the universe as a whole. It is not improbable that the conference marked the beginning of a new era in the study of stellar evolution. (The papers are more fully discussed by Dr. Cecilia Payne-Gaposchkin on page 11 of this issue.)

After the conferences in Puebla and Tonanzintla, the scientists first returned to Mexico City and then, after a day's relaxation, went on by automobile to the lovely town of Morelia. The Mexican authorities provided a "picnic lunch," which proved to be essentially a barbecue, served en route at Mil Cumbres, which lived up to its literal interpretation of "a thousand peaks." Here, at an altitude of about 10,000 feet, from a promontory of a mountain side, one could see almost countless jagged peaks, piled in a confusing jumble to the distant horizon. Here, also, native Morelian girls serenaded the party with the marimbaphone during our brief stay.

The following morning, Tuesday, promptly at 6:00 a.m., we were awakened by the sounds of firecrackers and a military band. Those who thought that the display was in honor of the visiting astronomers were soon corrected. The Mexicans were merely celebrating their Flag Day in appropriate ceremonial fashion.

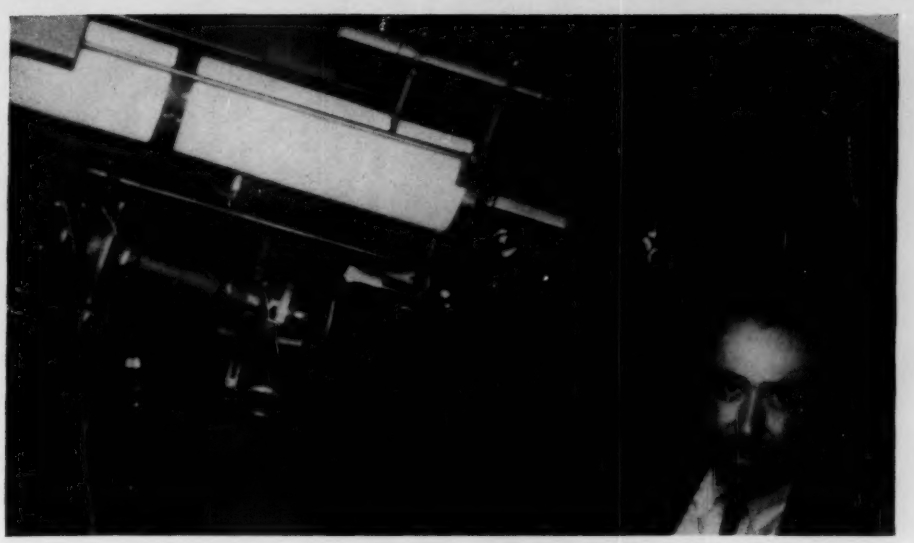
After breakfast, the group proceeded to the village of Tiripetio, where is located the University of Michoacan, founded in 1540, the oldest on the American continent. There, Drs. Adams, Russell, Shapley, and Vallarta received honorary degrees from the hands of the rector, Victoriano Anguiano. Later, in this almost primitive village, were parades and celebrations. Decorated ox carts formed a most unusual feature of the procession which, we were assured, was jointly in honor of the Mexican flag and the visiting astronomers.

The astronomers took luncheon on the shores of beautiful Lake Patzcuara. The entertainment provided consisted of a group of masked male dancers who gave an interesting exhibition of historic native pantomime, known as "the dance of the old men." Later, the party returned to Mexico City for the rest of the scientific conferences.

Two days prior to our departure from Mexico, President Camacho gave a luncheon to the members of the conference at the National Palace. It seemed significant indeed of the progressive attitude of the Mexican government that the president himself should meet with the astronomers on no less than five occasions, honoring the group and officially recognizing the importance of pure science. On the last day the American Embassy, with Ambassador and Mrs. George S. Messersmith as hosts, gave another luncheon to the assembled scientists.

As the group broke up, the evening of

Part of the beautiful home of Sr. Taboada, prominent Mexican astronomer, is his roof-top observatory, shown here.



Sr. Taboada and his well-equipped refractor.

February 26th, everyone expressed regret at having to leave Mexico. The conferences had been stimulating and at times strenuous, though never boring or tiresome. The interludes of sightseeing and of informal entertainment had been carefully planned, and proved a most welcome relaxation. There was the official reception by Governor Bautista, and the unforgettable garden party given for us by Mrs. Vallarta's father, Dr. César Margain, of Mexico City. There was the impromptu tea given by Mr. and Mrs. Harold Callender—he is the Mexican correspondent of the New York *Times*. There were the visits to the pyramids of Teotuhuacan and to the fine observatory of Mexico's leading amateur astronomer, Sr. Domingo Taboada, as well as the less official attendance at the bullfight.

One will never forget the beautiful scenery, dominated by Popocatepetl, and the perfect weather. One can scarcely express appreciation to the Mexican officials for such items as scenery and climate. But, for the arrangement and conduct of the conferences, must go the thanks of all those in attendance to President Camacho for his interest and courtesy, to Dr. Bautista, and the other officials of the Mexican government, especially to Sr. Salvador Duhart, first secretary of the Mexican Embassy, whose thoughtful attention to our comfort made the visit doubly pleasant. And finally, to Director Erro and Assistant Director Graef, of the new national observatory at Tonanzintla, go thanks and best wishes of all American scientists. It is to be hoped and expected that this new observatory, under such capable leadership, will rapidly assume its appropriate place in science as one of the most important observatories in the world. That Mexican science appreciates the cultural values is exemplified by the motto, in Greek, impressed on the main building at Tonanzintla. The words are from Aeschylus' *Prometheus:* "I free men from the obsession of death."

DO YOU KNOW?

By L. J. Lafleur

I. Score four points for each question correctly answered, and one point for each question where you do not attempt to select the answer.

1. There is no 1st-magnitude star in
   a. Carina c. Canis Minor
   b. Cepheus d. Cygnus
2. One of the following constellations does not contain part of the Milky Way:
   a. Circinus c. Caelum
   b. Norma d. Ara
3. The ecliptic passes through
   a. Sagittarius c. Cygnus
   b. Perseus d. Sextans
4. One of these constellations is sometimes visible from the latitude of New York:
   a. Volans c. Pavo
   b. Octans d. Corona Australis
5. There is a 2nd-magnitude star in
   a. Lynx c. Aquarius
   b. Lupus d. Pegasus
6. On an April evening you would not expect to see the constellation
   a. Serpens c. Leo
   b. Pegasus d. Canis Minor
7. One of the following is not the brightest star in its constellation:
   a. Alpha Herculis c. Alpha Scorpii
   b. Alpha Hydrae d. Alpha Tauri
8. The celestial equator does not pass through
   a. Pisces c. Capricornus
   b. Aquarius d. Ophiuchus
9. Which of the following is not a constellation:
   a. Corona Borealis c. Piscis Borealis
   b. Corona Australis d. Piscis Australis
10. A star brighter than the 4th magnitude could be found in
    a. Caelum c. Columba
    b. Crater d. Chamaeleon

II. In what constellation does each of the following points fall? Count four points for each correct answer.

1. north pole
2. south pole
3. north galactic pole
4. south galactic pole
5. north pole of the ecliptic
6. south pole of the ecliptic
7. vernal equinox
8. autumnal equinox

III. Match the stars in the first column with the constellations in the second. Count two points for each correct pair.

1. Achernar	a. Bootes
2. Aldebaran	b. Canis Minor
3. Algol	c. Cygnus
4. Antares	d. Eridanus
5. Arcturus	e. Gemini
6. Fomalhaut	f. Leo
7. Mizar	g. Lyra
8. Pollux	h. Orion
9. Procyon	i. Perseus
10. Regulus	j. Piscis Australis
11. Rigel	k. Scorpius
12. Sadr	l. Taurus
13. Spica	m. Ursa Major
14. Vega	n. Virgo

(*Answers on page* 23)

ASTRONOMY IN HARVARD'S SUMMER SESSION

OF particular interest to those who contemplate special war research or the teaching of war courses in science will be the special courses in astronomy to be offered during the summer session at Harvard this year. The university, which is now being run on a 12 months' continuous schedule, will not hold its usual Graduate Summer Conference in Astronomy and Astrophysics.

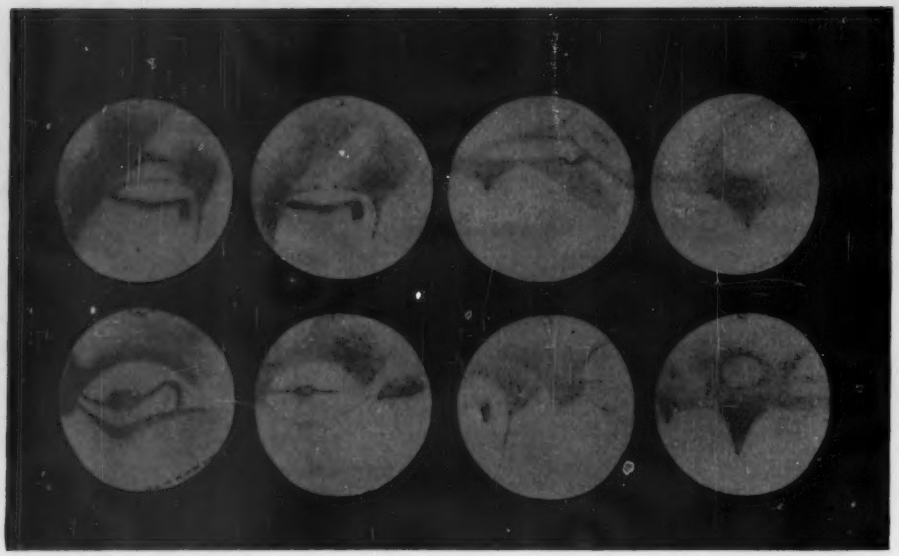
The summer session will be divided into two six weeks' period, one from June 29th to August 8th, and the other from August 10th to September 18th.

During the first period, James G. Baker will cover the theory and design of optical systems, lenses, mirrors, and combinations, in a course on "General Problems of Optical Systems."

Stress upon the photographic problems of importance in war activities will be made by Dr. George Z. Dimitroff in his course in photography, to be given in the second period. Also, during this same period, Dr. Donald H. Menzel's course in theoretical physics and astrophysics will include material suitable to the preparation of advanced war research students.

Adjustment of the regular undergraduate course in descriptive astronomy, to be given in the first period, has been made by Dr. Bart J. Bok, in order that it conform to the recommendations of the committee of Section D of the A.A.A.S. This, and Dr. Fred L. Whipple's two undergraduate courses in navigation, will be given in the first period.

There will also be a series of 12 colloquia on Tuesday evenings, open to visiting astronomers and students.



The author's drawings may be compared with the Mercator chart by E. M. Antoniadi, reproduced opposite. The south pole is at the top of each drawing.

TOP ROW					BOTTOM ROW				
No. (l. to r.)	*Date*	*Time (C.S.T.)*	*Central meridian*	*Power*	*No. (l. to r.)*	*Date*	*Time (C.S.T.)*	*Central meridian*	*Power*
1.	Sept. 7.....	6:15 a.m.	337°	240	5.	Aug. 27....	6:10 a.m.	77°	240
2.	Oct. 1.....	10:10 p.m.	356°	240	6.	Sept. 20..	11:30 p.m.	113°	240
3.	Oct. 17....	9:45 p.m.	209°	180	7.	Nov. 7.....	10:00 p.m.	25°	240
4.	Nov. 15....	5:30 p.m.	246°	180	8.	Nov. 15....	10:00 p.m.	311°	180-240

An Amateur Looks at Mars

By J. Russell Smith

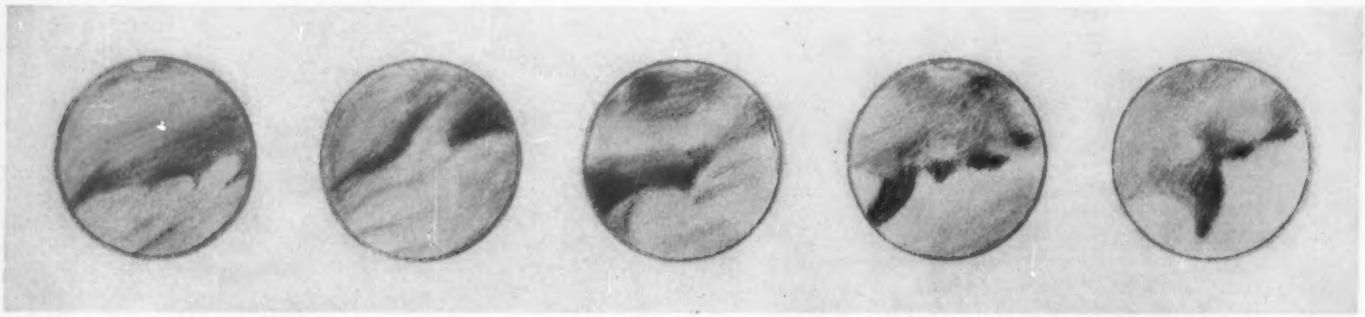
MARS seems to hold an interest of some sort for almost everyone. My first serious thoughts about our mysterious neighbor were aroused by a newspaper note in 1924. August 22nd of that year brought a very close approach of the planet, and the note in the paper stated that scientists would attempt to communicate with Mars by means of light signals from a deep mine. My young imaginative mind was set astir by such an article.

However, it was 1937 before I tried to make serious observations. Again, in 1939, the tube of my 8-inch Newtonian was swung toward Mars. The previous experience seemed to help a great deal, for I had learned that Mars is not an easy object for a telescope. Still, it is almost unbelievable that at times of good seeing, a small (6- or 8-inch) instrument will show a wealth of detail to the persistent observer.

Observers of Mars were favored at the 1941 opposition with a declination of plus four degrees, which made the apparition much more interesting than that of 1939, with a declination of *minus* 26 degrees. The maximum angular diameter of the planet was then about 24 seconds, while in 1941 the maximum angular diameter was only about 22".8. This difference was relatively unimportant, since the high altitude brought greatly improved seeing conditions.

All observations for the past three oppositions were made with my 8-inch Newtonian of 60 inches focal length. While it is probable that a longer focal length could have been used to advantage, the results were satisfying with a ¼-inch (240x) Tolles ocular (solid type). All drawings were made at the eyepiece and only what could be definitely seen was recorded. At times, I thought I could see more detail than that shown. Some of the observations were made through fog and thin clouds, which seemed to help in producing a "harder image," showing detail more clearly. In 1937, similar results were noticed while observing before sundown. In 1941, different colored filters were used in the hopes that detail could be more clearly observed, but they did not seem to help. Stops for the mirror were employed in 1939, but this procedure did not help. Seemingly, no method proved better than just looking through the instrument without any accessory whatever.

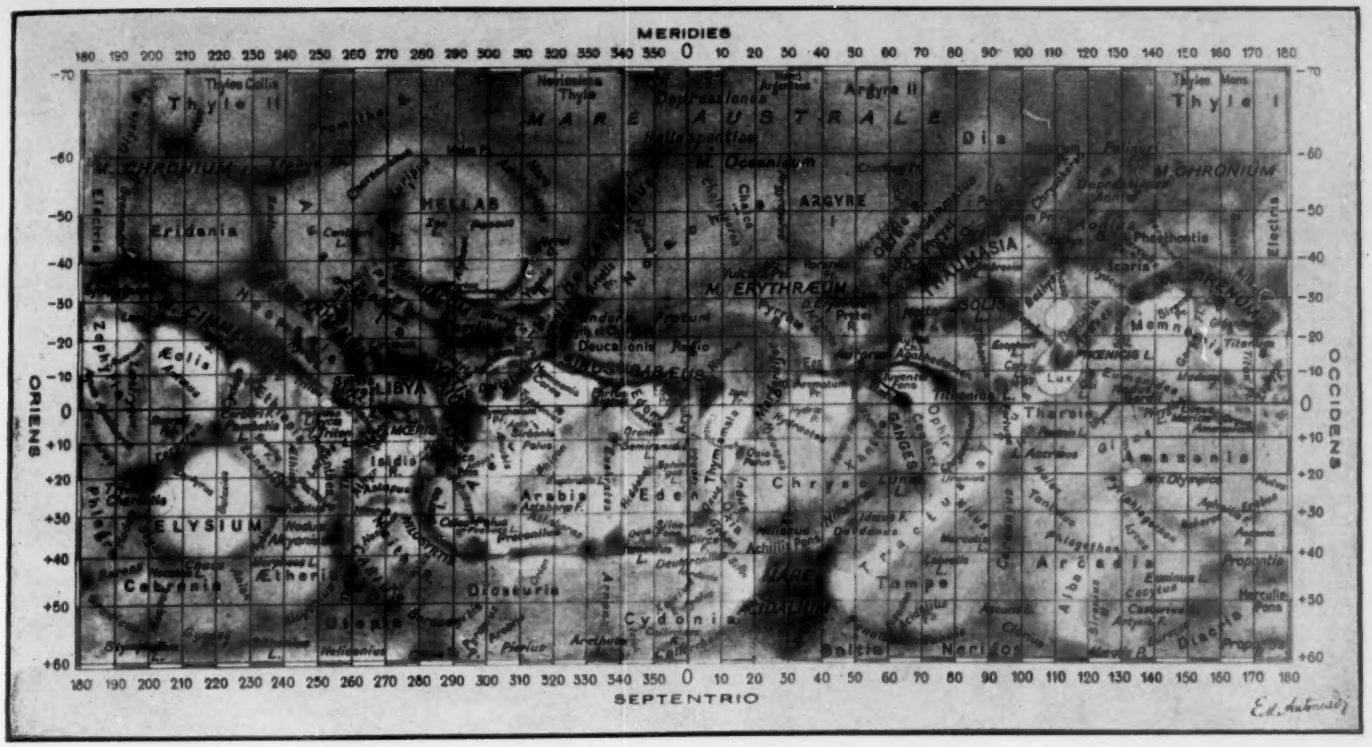
Mars has very little to offer the planetary observer except at or near opposition, and at the most recent one the southern hemisphere was well placed for observation, since the south polar region was inclined toward the earth. The south polar cap decreased considerably during the period of observation (August to December). It decreased faster than at recent previous oppositions, and at all times it was less outstanding or conspicuous. The brilliant white, which the cap has had previously, was apparently more of a grayish color and was not outlined by as many prominent dark bands. This apparent fading of color from the cap might possibly be due to a kind of optical illusion, since there was less white to contrast with the surrounding area. The south polar cap had a "niche" or indentation near longitude 77 degrees, as shown on drawing No. 5. Dr. R. S. Underwood, of Texas Technological College, Lubbock, Tex.,



These pencil sketches of Mars were made by R. Stuempfle, of Trujillo, Peru, and enclosed with his letter of October 10, 1941, printed on page 18 of *Sky and Telescope*, March, 1942. This amateur used a 6½-inch Newtonian, and 250 power, and says ". . . I have no astronomical ephemeris here, which would permit me to know the central meridian of Mars during these observations, so I cannot say if the drawings are correct. (This may be better for impartial observing.) . . . No filter or dark glass was used. . . ."

Numbering the sketches from left to right, the following times will help in making a comparison of them with the author's drawings, reproduced and described in the accompanying article:

1. 9-5-41, 11 p.m. E.S.T.; 2. 9-17-41, 10 p.m.; 3. 9-20-41, 9:45 p.m.; 4. 9-29-41, 9 p.m.; 5. 10-2-41, 8:45 p.m.



Mercator chart of Mars, drawn by E. M. Antoniadi from observations made with the 33-inch refractor at Meudon.

called my attention to this feature. (This was the only drawing made by both of us working together.) Any later observation did not reveal this, while both of us definitely noticed it at that particular time.

Colors, such as green, brown, pink, and blue, were not outstanding at any time, even with the use of filters. This may have been due to insufficient light grasp of the 8-inch mirror. Lack of color on the planet for the 1941 opposition has been confirmed by Oscar E. Monnig, of Fort Worth, Tex. However, he states that his 4½-inch refractor does not have an excellent color correction. Furthermore, it seems that I have never been very good on planetary color.

As you can readily see from the sketches, "canali" were practically unseen. Some observers state that the "canals" can only be seen in larger instruments, and others that they are observed with smaller instruments, while still others declare definitely that they are merely optical illusions. Many observers, with 6- and 8-inch telescopes, see many more such markings than I do. A number of observers of Mars think most of the "canals" are only divisions, which are quite abrupt, between areas of unequal shading. At any rate, observers do not agree on what is seen or on how it should be represented in drawing. My 8-inch showed several fine-lined markings in 1937, but fewer in 1939.

An attempt was made to show the relative intensities of the different markings, but the results reveal no great success. The gibbous phase has been shown with very little accuracy and no attempt has been made to draw the disk to scale.

Hugh M. Johnson, of Des Moines, Ia., a keen observer of Mars, has kindly furnished the central meridians given in the table. His own study of this opposition was interrupted due to his starting to work for the Bausch and Lomb Optical Company, in Rochester, N. Y.

Drawing No. 6 may be compared with 5, since they both show approximately the same face of the ruddy disk. In 1 and 2, another face is presented at two different times and interesting comparisons are obvious. Such changes are probably due to seasonal progression.

My identification of some of the markings or features for each drawing is:

1. The semicircular white area to the left top is Hellas and the large dark area below it is Syrtis Major. Hellespontus runs up from Syrtis Major toward and to the right of the south pole. Extending to the right from Syrtis Major and nearly across the center of the disk is Sinus Sabaeus, which has two small downward projections (Fastigium Aryn) at its right end. The white area just above Sinus Sabaeus is the Deucalionis Regio, while Margaritifer Sinus is the dark area with the long and narrow downward projection on the right side of the disk. The dark marking connecting Margaritifer Sinus with the left end of Sinus Sabaeus is Pandorae Fretum.

2. This drawing shows the same general features as 1, except in the upper central region. The large, white region extending upward and to the right from Pandorae Fretum is Noachis.

3. The dark, downward projection on the left side of the disk is the western portion of Mare Sirenum while the larger dark marking to the right is Mare Cimmerium. The light narrower area extending along the upper side of Mare Cimmerium and on to the right limb of the planet is Hesperia, and the dark area just above Hesperia is Mare Tyrrhenum. The light area, above Mare Sirenum and a portion of Mare Cimmerium, which extends from west to east is (west part) Eridania and (east part) Electris. I did not see a division between these two light areas as shown on the Antoniadi map. The marking just above Electris and Eridania is Mare Chronium, but the small dark area just above Mare Tyrrhenum is unidentified.

4. This shows the dark northward (down) projection known as Syrtis Minor which is a portion of Tyrrhenum Mare. The dark extension, to the left of Syrtis Minor, which extends to the left limb of the planet, is probably a portion of Mare Cimmerium, while Mare Tyrrhenum curves upward and to the right from Syrtis Minor. The white region, above Syrtis Minor, which extends to the right limb of the planet is Ausonia and **probably** a part of Hellas. The marking above Ausonia has not been definitely identified, but it is probably Xanthus, Tiphys Fretum, and Promethei Sinus.

5. The dark elliptical-shaped area near the center of the drawing is Solis Lacus, which is joined to the dark area, Aurorae Sinus, at the left, by Nectar. The dark curved region above Solis Lacus is Bosporus Gemmatus while the mark below Solis Lacus is Tithonius Lacus. The light region between Solis Lacus and Bosporus Gemmatus is Thaumasia, and the light semicircular area toward the top left of the disk is probably the edge of Argyre I.

6. The disk here shows the eastern portion of Mare Sirenum, which is located almost due west of Solis Lacus, on the limb of the planet. The light area to the upper left of Mare Sirenum is probably Icaria, which is joined on the left by the northward projection of Aonius Sinus.

7. The small marking near the eastern limb is Fastigium Aryn, which was not very clearly defined due to its being near the edge of the disk. Just to the west of

The Martyr of 1600

By Leland S. Copeland

THE only man who ever died for astronomy was a philosopher. He urged the world to accept the most humiliating and overwhelming ideas to which the human mind has given birth. But the rulers of thought were devoted to a heritage from the ancient world. They refused to listen; instead, they seized the teacher and destroyed him with fire.

Filippo Giordano Bruno (1548-1600), one of the most dramatic figures in the story of the stars, was among the first to grasp an enlightened view of the universe. Before proofs had been found by Galileo, Bradley, and Bessel, he defended Copernicus and taught the certainty of the heliocentric doctrine. He saw even more deeply into the realities around us and declared that there were countless worlds in an infinite universe. Daring further, he announced that study and reason were the guides to truth.

These ideas came as a stupendous shock to educated men of the 16th century. After half a million years of twilight and shadow, the human mind suddenly could not face the strong new light. The powers of this planet, frightened and indignant, struck at such "horrible absurdities," as they were described by a contemporary.

And so Bruno had to die. He was burned at the stake in the Flower Market at Rome on February 17, 1600. Three centuries passed. In that interval great astronomical discoveries accustomed men to the light that had streamed through Bruno's mind. On June 9, 1889, knowledge-lovers of many countries raised a monument in his honor on the spot "where the pyre burned." A picture of this memorial is shown here.

Bruno was born and spent his boyhood within sight of Vesuvius. At 15 years he was admitted to a monastery, where he gave much time to study, especially of ancient philosophy. When at 28 he was accused of heresy, he fled from the cloister and became a wanderer, first in Italy and then abroad. For 15 years he traveled, lectured on philosophy and astronomy, and wrote books. After passing through Switzerland, France, England, and Germany, he returned to the homeland. There he was betrayed by one of his students, Mocenigo the Venetian, and held in prison for the rest of his life.

A medium-sized man with thoughtful eyes, Bruno faced his enemies. At first, hoping for peace, he renounced his beliefs. But when the conservatives still held him, he returned to his convictions, by which he stood fast till death. He declared that he neither ought to nor would recant. After nearly eight years' imprisonment in Venice and Rome, he was condemned, in words of velvet cruelty, to die "without the shedding of blood." He said to his judges, "Greater perhaps is your fear in pronouncing my sentence than mine in hearing it."

Martyrdom did not mean to Bruno, as to John Bradford, "a merry supper with the Lord." To the philosopher it signified transformation. "There is no death for us or any being, but all things flowing through infinite space only change in appearance." For him death opened on a new adventure in another body somewhere in a boundless cosmos.

A few of Bruno's best sayings, condensed and rearranged, are presented here:

"In nature are the thoughts of God. The heavens are a book in which man can read the laws of supreme goodness. By this knowledge we are loosed from a narrow dungeon and set at liberty to rove in a most august empire; we are removed from presumptuous boundaries and poverty to the innumerable riches of an infinite space. Only one bereft of reason could believe that those spaces, tenanted by magnificent bodies, are designed only to give us light. Earth holds her rank by usurpation; it is time to dethrone her. The distinction between heaven and earth disappears before a wider knowledge. From the vast worlds that circle above us to the sparkling dust of stars beyond, there is an infinity of creatures, each with eternity for duration, immensity for place, omniformity for realization.

"Investigation of nature in the unbiased light of reason is our only guide to truth. The true purpose of life should be illumination, the true morality the practice of justice, and the true redemption the liberation of the soul from error."

Those who dislike Bruno point to errors in his astronomical and philosophical writings. But the marvel is that he could read so deeply in the "infinite book of secrecy"; that he anticipated facts which scientists were to discover, including the rotation of the sun.

In 1600, science did not need a martyr, because courageous dying cannot demonstrate truth. What the world especially lacked was what it obtained nine years later—the celestial telescope.

But the brave sacrifice in the Flower Market showed what high value could be placed on the untrammeled pursuit of knowledge. For this reason men will remember Bruno as long as they love liberty.

Though the future may yield greater discoveries than the past, astronomy probably never again will induce such an intellectual crisis as that which it caused in the days of Bruno and Galileo. Both were vanquished completely, but their ideas about the heavens passed on to victory.

Filippo Giordano Bruno, " . . . to the innumerable riches of an infinite space."

AN AMATEUR LOOKS AT MARS

(*Continued from preceding page*)

the above-mentioned feature is our old friend, Margaritifer Sinus, which is followed to the west by Aurorae Sinus. The other markings to the west are comparable to those found on drawings 1 and 2.

8. The elliptical white region near the center of the disk is Hellas and the dark area extending below it is our well-known friend, Syrtis Major. The smaller dark projection toward the north, which is located near the eastern limb, is Syrtis Minor. The other features can be identified by reference to drawings 1 and 2.

Additional Comments:

On August 27th (11:15 p.m.), my drawing shows the Fastigium Aryn region to be clear and distinct, while thereafter the same area was not so clearly defined. The region of Solis Lacus seemed to have a different shape to that of the previous (1939) opposition. It was apparently more elongated and larger on August 27th (6:10 a.m.) than on September 20th.

The northwestern limb of the planet was noticeably bright and white on August 27th (6:10 a.m.) but such was not observed on September 20th. Again on November 15th the northwestern edge was unusually bright. These bright limb areas are indicated on the drawings by broken lines.

It seems that these notes would be incomplete without a word concerning the markings in the northern hemisphere. One will readily see that my drawings show none. My drawing for August 17th (6:25 a.m.) shows Trivium Charontis to be clearly defined but it is not shown again on **any** drawing. Some faint markings were suspicioned in the northern hemisphere at times but these were too indefinite and indistinct to be recorded.

THE ERA OF NABONASSAR

By Edgar W. Woolard
United States Weather Bureau

THE 8th of May, 1942 (Gregorian calendar), is the first day of the year 2691 of the Era of Nabonassar. Historically, this era commemorates the accession of the monarch Nabu-nazir, the Nabonassar of classical writers, to the throne of Babylon in 747 B.C.; in the annals of astronomy, the era, in addition to being famous because extensively used by Hipparchus and Ptolemy for expressing dates of celestial phenomena, is deserving of recognition from everyone interested in astronomy because it may reasonably be considered to commemorate the active beginning of the development of modern astronomy.

During recent years, historical studies have established the fact that ancient Greek astronomy, from which the modern science has directly developed by continuous progressive transformation and extension, was constructed largely on Babylonian astronomy as a foundation. Although Babylonian astronomical observations extend back to before 2000 B.C., it was not until the 8th century B.C., in the reign of Nabonassar, that a continuous series of carefully recorded systematic observations was begun, which extended over several centuries and gradually provided the later Babylonians with an accumulation of data on which they founded their remarkable system of astronomy.

This system, even though it was entirely empirical, embodied some of the most noteworthy astronomical achievements of ancient times, and was the beginning of an unbroken development that eventually led to the now accepted fundamental principles of astronomy—the Babylonian results were an essential element in the Greek developments that culminated in the work of Ptolemy, from which the systems of Copernicus and Kepler were explicitly derived by revisions in only the particular respects necessary, the previous developments being otherwise conserved; on this foundation, the Newtonian system was erected and has developed into astronomy as it now exists, nearly 30 centuries after its beginnings in the ancient Orient.

Nabonassar was a comparatively undistinguished king of Babylon, whose reign (747-733 B.C.) came during the late Assyrian period. The Assyrians had commenced to build up an empire in western Asia about 1300 B.C., at a time when Babylonia was ruled by the Kassites; and for several centuries a state of intermittent conflict existed between the Assyrians and the city of Babylon. Nabonassar, however, was a loyal ally of the Assyrian monarch, Tiglath-Pileser III.

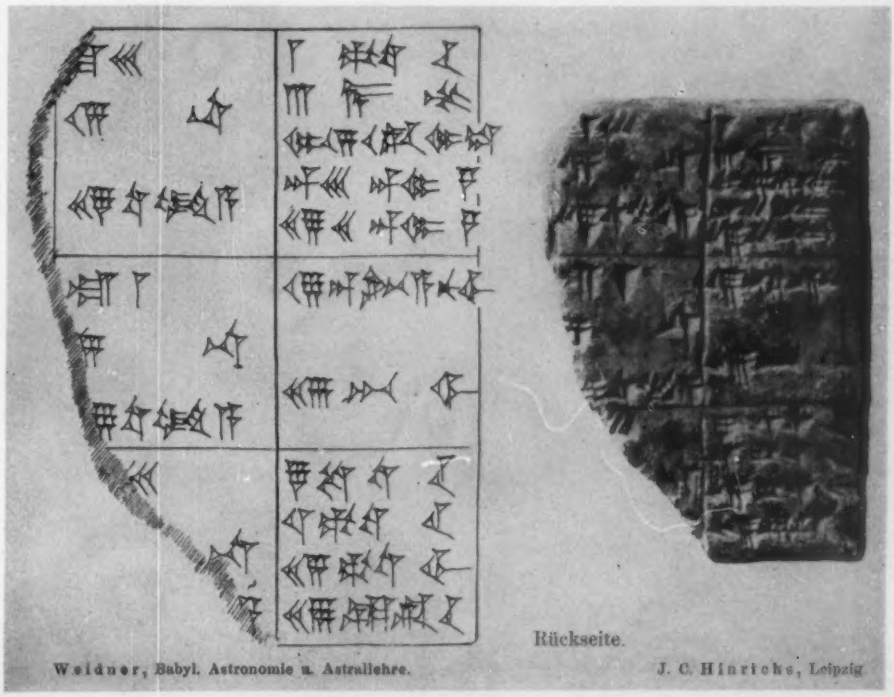
The circumstances of the introduction of the Era of Nabonassar are not known, though a number of speculations have been advanced. The era may have been put into actual use by the Babylonians at the time of its epoch, and if so it was the first of all known chronological eras to be adopted; at least it is probable from the indirect evidence available that this era was used by the later Babylonian astronomers.[1] Apparently it was employed for historical purposes in Babylonia until the time of the Seleucid Empire that was formed after the death of Alexander the Great; and it is the basis of the famous Canon of Kings in the writings of Ptolemy, which was long the only known authentic record of Assyrian and Babylonian history. The Babylonians, of course, used their own calendar (which was a lunisolar one) with the era; but the technical chronological practice has been to follow the example of the ancient Greek astronomers and use the Egyptian calendar.

The epoch of the Era of Nabonassar may be very precisely determined from the numerous celestial phenomena recorded by Ptolemy in the *Almagest*—most readily, perhaps, from the eclipses. The era began on February 26, 747 B.C., Julian proleptic calendar; and Ptolemy (*Almagest*, III, 6) reckoned the days from noon of the meridian of Alexandria. The first day was therefore Julian Day (*current*) 1,448,639. (January 1, 4713 B.C., Julian calendar is J.D. *current* 1.) The year used is the Egyptian Vague Year of 365 days, containing 12 months of 30 days each, followed by five epagomenal days, and beginning with 1 Thoth. The Babylonian New Year Day (1 Nisan) in 747 B.C., however, began at sunset on March 23rd, Julian calendar, according to Kugler, differing by nearly a month from the first day of the era as later established in the Egyptian calendar.

It has been suggested that a series of striking celestial phenomena which occurred during the first year of Nabonassar's reign may have been responsible both for the series of astronomical observations that was then initiated, and for the introduction of a new era for reckoning the years in addition to the then prevailing custom of designating them according to the year of the currently reigning king. At any rate, the heavens as seen from Babylon on the evening of March 23, 747 B.C., presented an interesting and beautiful appearance. Computing the positions

The establishment of Babylonian astronomy as early as 1300 B.C. is illustrated by this cuneiform inscription from the Kassite period, found in Nippur. On the back of the tablet (shown here) one column is complete. Note the system of tens and units for recording figures. (Translation and figure adapted from Weidner, *Babylonische Astronomie und Astrallehre*, Leipzig, 1914.)

Days of month		*Translation of inscription*
(Tesritu)	1	Mercury—heliacal setting
	3	Autumnal equinox
Night	15	at 10 US (40m) = 6:40 p.m.
		Moon eclipsed
	28	Sun eclipsed
(Arah-samna)	18	Mars—heliacal rising
	26	Venus—heliacal rising
(Kislimu)	7	Jupiter—heliacal setting
	11	Mercury—heliacal setting
	25	Mercury—heliacal rising
	28	Saturn—heliacal setting



of the sun, moon, and planets on that evening,[2] we find the appearance of the sky to have been as follows:

Object	Eastern elongation	Constellation	Magnitude	Latitude
Moon	20°.8	Near Pleiades	....	+4°.4
Mercury	20°.1	Near Pleiades	0.0	+2°.6
Venus	32°.7	Between Pleiades and Hyades	—3.5	+0°.8
Mars	18°.3	Near Pleiades	+1.7	0°.0
Jupiter	189°.8	Near α Librae	—2.1	+1°.6
Saturn	299°.5	In Aquarius	+1.3	—0°.9

The sun lacked 5°.2 of having reached the vernal equinox; the equinox was then in the constellation Aries, about 37 degrees east of the present position; the longitude of α Arietis (Hamal) was close to zero degrees.

On this evening, the thin crescent of the new moon (age about 1 day, 18 hours) was visible in the western twilight for the first time during the new lunation; and, according to Babylonian custom, its appearance heralded the beginning of a new calendar month. At Babylon (latitude +32°.5), shortly after sunset, the ecliptic extended upward from the western horizon at a high angle. As the sky darkened, Mercury and Mars appeared, close to the lunar crescent, while above them Venus shone resplendently between the Pleiades and the Hyades; in the early evening, Jupiter also came into view above the eastern horizon. The brilliant constellations that now appear in our winter skies were visible in the southwestern quarter of the heavens, with Castor and Pollux high overhead. Saturn was a morning star.

Nabonassar's first year was also distinguished by several other noteworthy phenomena to which great astrological significance must have been attached, among them being a close conjunction of Mars and Jupiter on February 26, 746 B.C., near the bright stars of Scorpius, and one of Venus and Jupiter, December 12, 747 B.C., also in Scorpius.

Dates in the Gregorian calendar corresponding to given dates expressed in the Era of Nabonassar are most conveniently found by first converting to the Julian Era or to the Julian calendar; the Julian calendar date on which the current year of Nabonassar begins is given annually in the list of "Chronological Eras and Cycles" in the *American Ephemeris*. Tables have been constructed for making conversions,[3] and formal rules have also been devised that may be used when tables are not available;[4] but the fundamental data needed for the conversion of dates at any specified period may readily be derived as follows:

In the Julian calendar, the day 1 Thoth beginning the year 1 Nabonassar is 26 February, 747 B.C. The successive years of the era each begin after the lapse of one Egyptian year, which is invariably 365 days; hence a year of the era will begin on the same date in the Julian calendar as the preceding year unless a Julian bissextile day has intervened, in which case the beginning will be one day earlier in the Julian calendar. The first leap year in the Julian proleptic calendar after the epoch of the era is 745 B.C.; the intercalary day is subsequent to the beginning of year 3 Nabonassar (see Table 1), hence with the commencement of 4 Nabonassar the Julian date of 1 Thoth drops back to February 25, where it remains for four years; and so on.

As the date of 1 Thoth continues to drop back one day every fourth year, it eventually falls on January 1st of a leap year, and when this happens the next year of the era begins on December 31st of the same Julian year; the first such occurrence was in 521 B.C. Then, in time, 1 Thoth falls on a bissextile day, as first happened in 704 A.D. Finally, 1 Thoth returns to February 26th again as year 1461 Nabonassar begins; this year, which ended with February 25, 714 A.D., completed a Sothic cycle of 1461 Egyptian years (1460 Julian years), during which the Egyptian New Year Day makes a circuit of the Julian calendar.

Table 1 extends in outline over two Sothic cycles; and from it a detailed table may easily be constructed for any desired interval. Table 2 shows the relations for the 10 years 1939-1948, inclusive.

The Era of Nabonassar is an appropriate reminder of both the geographical region where modern astronomy had its source, and the remoteness of the period of history at which its development began.

TABLE 1. JULIAN DATES OF 1 THOTH

I. Year Nabonassar	B.C.	First day	II. Year Nabonassar	A.D.	First day
1	747	Feb. 26	1462	714	Feb. 26
2	746		1463	715	
3	745*		1464	716*	
4	744	Feb. 25	1465	717	Feb. 25
5	743				
6	742		. . . . .		
7	741*		. . . . .		
8	740	Feb. 24			
. . . . .					
227	521*	Jan. 1	1688	940*	Jan. 1
228	521*	Dec. 31	1689	940*	Dec. 31
229	520				
230	519				
231	518				
232	517*	Dec. 30	. . . . .		
. . . . .					
747	2	Aug. 24	. . . . .		
748	1*	Aug. 23			
	A.D.				
749	1				
750	2				
751	3				
752	4*	Aug. 22			
. . . . .					
1451	703	Mar. 1	2912	2163	Mar. 1
1452	704*	Feb. 29	2913	2164*	Feb. 29
1453	705	Feb. 28	2914	2165	Feb. 28
1454	706				
1455	707				
1456	708*				
1457	709	Feb. 27	. . . . .		
1458	710				
1459	711		. . . . .		
1460	712*		2921	2172*	Feb. 27
1461	713	Feb. 26	2922	2173	Feb. 26

*Julian leap year.

TABLE 2. DATE OF 1 THOTH, 1939-1948 A.D.

Year A.D.	Julian calendar	Gregorian calendar	Year Nabon.
1939	April 26	May 9	2688
1940*	25	8	2689
1941	25	8	2690
1942	25	8	2691
1943	25	8	2692
1944*	24	7	2693
1945	24	7	2694
1946	24	7	2695
1947	24	7	2696
1948*	23	6	2697

*Julian leap year.

[1] F. X. Kugler, *Sternkunde und Sterndienst in Babel*, II, 362-371.
[2] Karl Schoch, *Planeten-Tafeln fur Jedermann*.
[3] R. Schramm, *Kalendariographische und Chronologische Tafeln*, Leipzig, 1908.
[4] F. K. Ginzel, *Handbuch der mathematischen und technischen Chronologie*, I, 143-146, Leipzig, 1906.

Astronomy at the Inter-American Scientific Conference

Compiled by CECILIA PAYNE-GAPOSCHKIN
Harvard College Observatory

ALONE among the important modern observatories, the new observatory at Tonanzintla, Mexico, commands a view of the whole Milky Way. It was therefore fitting that the theme that held together most of the astronomical papers presented at the occasion of its dedication should have been the structure and constitution of the galaxy, and its relationship to other galactic systems.

Study of the composition of the interstellar medium calls for powerful instrumental equipment, because the interstellar lines are to be observed only on a background of the spectra of distant stars. In reviewing the work that has been done at Mt. Wilson on the study of interstellar lines, Dr. Walter S. Adams enumerated 23 such lines, many of known origin, the newest and most interesting being the atom of ionized iron. Even more important than this information on the composition of the interstellar material were his results concerning the multiple character of the lines of ionized calcium—data that point without doubt to the existence of several such clouds in the line of sight between us and the observed star, with relative speeds of 10 or 20 kilometers a second.

Irregular distribution of absorbing atoms in the line of sight links up immediately with the very important results, reported by Dr. Joel Stebbins, of his photoelectric measures of the irregularly distributed absorbing clouds in the galactic plane. These data have given a final answer to the question of whether the quality of the absorption (in its effect on light of different colors) is different in different parts of the sky. It is the same everywhere—a result equally important to the people who wish to allow for the absorption, in their studies of obscured stars, and those who wish to study the nature of the absorbing material.

Another paper that dealt indirectly (but very definitely) with the absorbing substratum of the galaxy was that of Miss Henrietta Swope concerning the faint variable stars in Ophiuchus and Sagittarius. The bright eclipsing stars, relatively unaffected; the swath of absorption cut across the distribution of faint cluster-type and long-period variables in the low-latitude regions; and the novae, crowding to the edges of the dark clouds, gave added significance to, and received it from, Dr. Stebbins' results of reddening in the same regions.

The relation of stars to nebulosity, closely allied to the problems of the interstellar medium, was the subject of Dr. Otto Struve's discussion of the Pleiades. (See back-cover photograph.) He pointed out the strong relationship between the velocity of rotation of a star and its position in the cluster, and made a suggestion concerning the role that might have been played by the nebulosity in producing the rotation.

In a more fundamental sense, Dr. Fred L. Whipple's paper was also concerned with the relation of nebulosity to stars, for he discussed the small interstellar dust clouds as the mode of origin of stars. This is a piece of work that has filled a serious lack in the study of stellar evolution, for although the extreme youth of the red giant stars has long been admitted, up to the present time we have sought in vain for ways in which their supply might be replenished. The condensation of interstellar dust clouds, with radiation pressure as an important factor, provides a way out of the difficulty.

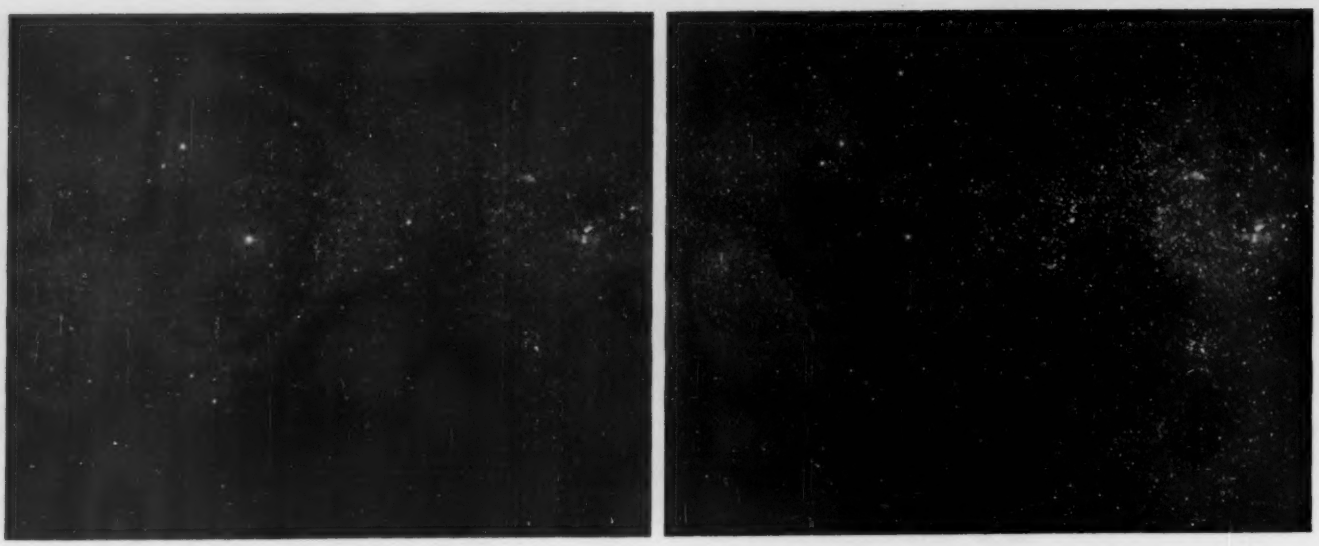
Evidence relative to the energy sources and development of the red giant stars that constitute the "great sequence" of intrinsic variables was presented by Dr. S. Gaposchkin in his paper on the classification of variable stars; the several groups of red variables can be plausibly associated with nuclear transmutations involving several atomic nuclei, from lithium to boron.

A general paper, devoted to the Bethe theory of stellar evolution, especially in its application to main sequence stars, was given by Dr. H. N. Russell. He described the probable life history of a star with mass equal to that of our sun. Starting with a surface temperature of hardly more than 3,000 degrees centigrade, and 91 per cent of its weight in hydrogen, it will grow brighter as it consumes its hydrogen through Bethe's carbon cycle, pass through the solar stage, and finally reach a stage where only one per cent of hydrogen will be left, and the star should have a surface temperature of 15,000 degrees and a total brightness equal to 27 times that of our sun. Ultimately, this star will become a faint white dwarf.

If the stars are being formed and extinguished all the time, Dr. Russell predicts that for every star with a mass like that of our sun in the solar or pre-solar stage, we ought to observe seven stars in the brightish post-solar stage. This is definitely not so, for no stars have been observed with masses equal to those of our sun, but with surface temperatures of 10,000 degrees and more, and much more luminous intrinsically than our sun. This fact gives a strong support to the short time-scale of the universe, according to which its age is of the order of two or three billion years.

Dr. Russell pointed out two puzzling conclusions: 1. The existing white dwarfs cannot have reached their present stages through an evolutionary process; they must have been "born" as white dwarfs; 2. The supergiants consume energy at so high a rate that they cannot have kept up at the present rate for as long as two billion years. Dr. Russell suggests that they may have persisted in a non-luminous pre-

The opening session of the conference. At the table, reading clockwise, are Dr. Vallarta, Dr. Shapley, former President Rodriguez, of Mexico, President Camacho, Dr. R. Monges-Lopez, Governor Bautista, and the secretary of education of Mexico. Along the walls of the chamber, on the raised seats, are the visiting scientists.



Blue and red photographs (*left* and *right*) of the southern Milky Way. The Carina region is at the extreme right. Note that there are no outstanding differences in the general distribution of stars and nebulosity in red as compared to blue light.

stellar state, and that their outer layers were then very opaque. There are still many unexplained facts not covered by this form of theory of stellar evolution, and the paper provoked stimulating discussion.

The general theme of stellar evolution linked together all the papers hitherto described. It is interesting to note the shifting of emphasis to the early stages of the process and encouraging to find that the theory of the pre-stellar stages (hitherto such a bar to progress) seems to be taking definite form.

If we pass from relatively small-scale problems concerning the galactic substratum and individual stars (the W Ursae Majoris stars, discussed by Dr. F. Recillas, and novae, touched upon by Dr. C. Payne-Gaposchkin), we come to the problems of galactic structure. The analysis of the stellar population in the Milky Way, organized a number of years ago by Dr. Bart J. Bok, is bearing fruit in systematic studies of various galactic regions. Perhaps the most interesting galactic region of all—of especial interest, also, to the delegates, many of whom saw it for the first time with their own eyes—is the region of Carina. Its extraordinary depth and richness, its wealth of Cepheid variable and eclipsing stars, its quantities of very blue stars and poverty in red ones, above all, its freedom from the troubles of obscuration, single it out for investigation and discussion.

Dr. Bok spoke of the intensive spectroscopic and photometric survey of the region that his department is now completing, especially of the evidence of absence of color excess (and therefore of obscuration) in this direction. He even indicated, on the photograph of another galaxy, the probable position of our sun, far from the central regions, and of the analogue of the Carina region (a spiral arm). Another contribution to the structure of the galaxy, in the Aquila region, was described by Dr. R. H. Baker; here obscuration plays an important role, and the contrast with the region of Carina is very striking.

Dr. Joaquin Gallo, director of the observatory at Tacubaya, Mexico, presented the results of a laborious study of star counts on his astrographic plates.

The Dominion Astrophysical Observatory has been a leader in the accumulation of radial velocities, and Dr. J. A. Pearce, the director, presented the results of a discussion of the rotation of the galaxy on the basis of their own, as well as other, measures of the radial velocities of the *B* stars. With the accumulation of knowledge, not only of the velocities, but of the luminosities, obscuration, and distances, of these stars, superb material for discussion of galactic rotation has now been obtained.

The researches of Dr. N. U. Mayall on the velocities of 53 globular clusters were perhaps the most controversial of all the reports presented at the meeting.

It has generally been assumed that our sun moves around the galactic center at a rate of 273 kilometers per second. Dr. Mayall's computations show that, with respect to the globular clusters, the sun moves only at a rate of 172 kilometers per second. This means either that the previous estimate was in error by 100 kilometers per second, or that the globular clusters are not on the average at rest in our galaxy, but that they partake in the rotation at a rate of 100 kilometers per second. Dr. Mayall shows that the question can be settled most satisfactorily by the measurement of an additional 20 or 30 radial velocities for clusters that are too far south for observation from Lick Observatory.

Dr. Harlow Shapley's address on "Time and Change in the Metagalaxy" was a report on recent galactic explorations, especially researches carried out at Harvard.

The survey of the whole sky, which will provide a census of the galaxies out to a distance of approximately 100,000 light-years, is now about two thirds completed. More than 400,000 systems have been newly recorded, each comparable to our own Milky Way galaxy. About a thousand million million stars are involved in the study. The object of this census is to examine the clustering of galaxies into organizations of various sizes; many groups of galaxies have been found.

A study of the dimensions of galaxies shows that they are much alike whatever the type. The spheroidal structureless systems can be traced to great distances from their nuclei. The arms of a spiral galaxy (and three fourths of the galaxies show these spiral arms) appear to be condensations within the system rather than ejections from a centered nucleus. Less than 20 per cent of the light of a typical spiral galaxy is in the spiral arms; most of it is in the little-noticed background of the galaxy. These new results on the sizes of galaxies provide subject matter for speculations on the evolution of galaxies like our Milky Way.

Variable stars are a powerful tool for the study of the dimensions and structure of galaxies. Around the center of our own galaxy there is an abundance of Cepheid variables of very short period (less than one day) and of Cepheids of unusually long period, around 16 days, but hardly any of normal period, such as those in the sun's vicinity (three to eight days). Many variable stars in our galaxy are found to be as distant in the anti-center direction as we ourselves are distant from the center, that is, about 30,000 light-years.

A number of the investigations reported dealt rather with material and method than with results. Especially in studies of galactic structure are the fundamental problems of photometry and spectral classification of prime importance, for only if these observations are free from systematic errors can the final investigations hope to reach significant results. The papers that dealt with photometry and spectral classification were therefore a source of real satisfaction.

Dr. Marie Pishmish Recillas, after outlining the basic problems of photometry

as applied to galactic structure, reported on her revisions of a number of important magnitude standards, chosen for their vital bearing on galactic counts and surveys.

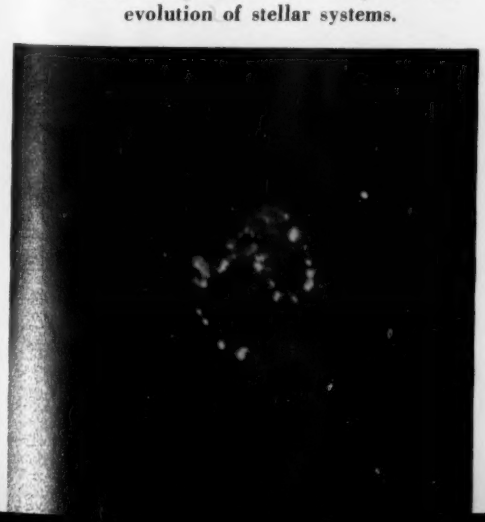
Dr. Carlos Graef, assistant director of the observatory at Tonanzintla, presented a paper dealing with a technique for the measurement of stellar colors. The underlying principle is that a region is first photographed through a blue filter. Next, a graded series of exposures of varying duration is made on the same plate through a red filter. The color of a star is measured from a comparison between the sizes of the "blue" and "red" images, then compared with colors for the same stars determined by the standard method of polar comparison plates.

Three papers dealt with problems and results in spectral classification, a subject as vital as photometry and beset with even more pitfalls. The time has come when spectral classification must proceed from the point to which Miss Cannon carried it either by reaching fainter stars or by attaining greater refinement. In his paper, Dr. W. W. Morgan illustrated the former aim by describing his collection of series of type spectra, to be used both for assigning accurate spectral classes, and for estimating luminosities. The forthcoming Yerkes atlas of stellar spectra will furnish an unparalleled guide to the study of spectra with moderate dispersion.

The extension to fainter magnitudes of spectral classification, and a systematic coverage of the northern sky on a uniform system, form the ambitious plan on whose progress at the McCormick Observatory Dr. A. N. Vyssotsky reported. Besides comparing his own system of spectral classification with all those embracing the same stars, he hopes to discover a number of faint objects with spectral peculiarities. He called attention to the importance of studying the detailed distribution of stellar types, and the dangers of assuming that any region shows "typical" distribution.

A paper that was of great importance to everyone concerned with spectral classification was Dr. R. W. Wood's talk on large objective gratings. He described the making of these multiple gratings, which concentrate most of the light into one "order" and illustrated their use.

An abnormal "ring-tail" galaxy, NGC 4038-9, complicates the study of the evolution of stellar systems.



Several papers, standing somewhat apart from the rest, dealt with the solar system. Solar variability was discussed by Dr. D. H. Menzel. He spoke of the extent of variable phenomena on the sun, and of the identification of Dr. Bengt Edlén, of Upsala, Sweden, of the coronal lines as caused by multiply-ionized lines of iron, nickel, and calcium. He endorsed Edlén's identification and expressed his readiness to accept a corona with a temperature of one million degrees over a solar surface with an average temperature of 6,000 degrees. He made the further suggestion that ejection of matter from the sun's interior may be an important factor in yielding the high temperature of the corona.

The lecture by Dr. R. R. McMath, entitled "Solar Prominences," and illustrated by motion pictures, described the work done at the McMath-Hulbert Observatory of the University of Michigan. Dr. McMath and his associates study the motions of solar prominences in three dimensions, thus gaining a complete space picture of the phenomena. The most remarkable result of this research is that 90 per cent of the prominences show matter in descent only, with no indication of how the material previously ascends.

An investigation that technically falls within the solar system, but that has repercussions that are felt throughout the study of the evolution of stars and the lives of galaxies, was the contribution of Dr. R. D. Evans, of Massachusetts Institute of Technology. He presented a paper on "Measurements of the Age of the Solar System." For iron meteorites the ages are determined by measuring the amounts of helium produced as by-products of radioactive disintegration. The upper limit for the ages of meteorites appears to be two billion years, not very different from the age of the earth.

The helium method breaks down for stony meteorites, and a new technique has been developed by Dr. Evans and his associates. The ages are estimated from relative activities of long-lived radioactive isotopes (same atomic number, different atomic weights) of some elements. Examples in terrestrial samples show that the radioactive independent isotopes of uranium, potassium, carbon, oxygen, and others, always occur in the same proportions, which suggests that these were all formed simultaneously. Measurements of meteorites from the fall at Pultusk all show the same relative abundance of radioactive isotopes, thus suggesting the same age for these meteorites and the earth. All data are in substantial agreement and show that the ages of the earth, of meteorites, and of individual atoms of all elements in the samples are equal to between two and two-and-a-half billion years.

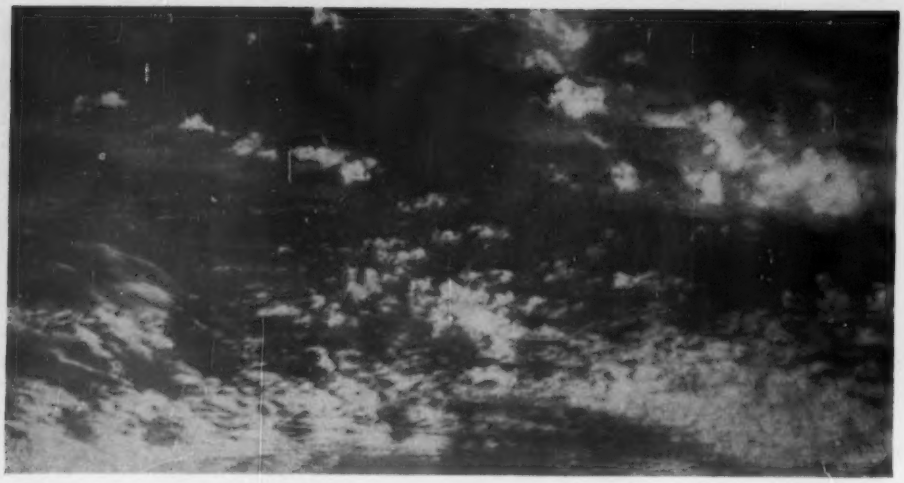
Another paper of primarily terrestrial significance was that of Dr. C. T. Elvey, of McDonald Observatory, who discussed problems of the night sky. His results show that a portion of the night sky light that arises in our earth's atmosphere is principally produced at a height of 125 kilometers, the region of the E-layer in the ionosphere. On most nights the intensity of the night sky radiations is subject to considerable variations; quiet nights are only recorded when the magnetic activity is small. Preliminary observations indicate that the variations in the intensity of the light are correlated with variations in the signal strength of broadcasting stations. This is in line with the suggestion that the night sky radiations originate in the E-layer of the ionosphere.

The study of the earth's atmosphere links the astronomical papers proper with a very important subject that is really astronomical, though it is mainly in the hands of the physicists—the problem of cosmic rays. Dr. M. S. Vallarta, who has long been a leader in the theory of this subject, spoke on "The Emission of Charged Particles by the Sun."

Some very valuable mathematical papers on the subject of the paths of the cosmic rays in the earth's field (a subject in which Dr. Vallarta has been a pioneer) were presented by Dr. Graef, Dr. Lifshitz, Dr. Martinez, and Dr. Banos.

One other paper dealing with the earth was that given by Dr. L. Don Leet on "New Developments in the Measurement and Interpretation of Earthquake Records." He spoke about local earthquakes and the structure of the crust near certain seismographic stations. Artificial earthquakes (quarry blasts) are very useful for studies of this sort. Early data on travel times of certain waves showed that there existed a marked discontinuity at a depth of 15 kilometers near the base of the granitic layer. Recent observations have modified this picture in many ways; for example, there is considerable variation from one station to another in the depth at which the discontinuity occurs.

One of the most significant contributions to the conference was Dr. George D. Birkhoff's discussion of "The Mathematical Concept of Time." After considering the implications of the ways in which the idea of "time" has been used in physics and relativity, Dr. Birkhoff sounded a note of warning. He fears that theoretical physicists are not giving sufficient attention to the special and general theories of relativity in their relation to quantum mechanics. Dr. Birkhoff has already shown that the quantum equation of Schroedinger may be derived from general relativity, and he now adds that on the basis of special relativity alone he derives the well-known results for the advance of perihelion of Mercury and the curvature of light in its passage by the sun. In this new theory the theoretical red shift is less than that expected from general relativity. From the standpoint of the larger aspects of cosmic evolution, these considerations should be of the greatest significance.



Cirro-cumulus and alto-cumulus, with virga—little snow flurries in the sky. View north from Blue Hill Meteorological Observatory, July 21, 1937, 3:24 p.m. This and lower two photographs taken by the author.

CLOUDS

By Charles F. Brooks

Director, Harvard's Blue Hill Meteorological Observatory

CLOUDS have interest for all of us. To some, it is merely a matter of dull skies versus bright, or that thickening clouds suggest rain, or that they occasionally make a fine sunset. To others, it is a professional matter: what do the forms of the clouds mean as to coming weather; how do their movements reveal the complex pattern of the winds aloft; how much will they hinder flying today, or help a bombing attack, or provide screens for fighting aircraft?

Clouds are composed of myriads of particles of liquid water or ice, usually of microscopic size, with diameters ranging from 1/500 to 1/10 of a millimeter, or from 12,000 to 250 particles to an inch. Liquid or ice particles of smaller and larger sizes exist; but when smaller they are considered to be merely particles of haze and when larger they are called rain or snow.

Cloud particles are generally so small that they can fall through the air at only an almost imperceptible rate. A droplet of average size descends at a rate of only four centimeters a second (less than two inches), which in an hour amounts to only about 150 meters (500 feet, roughly). As late as the middle of last century it was thought that cloud particles must be little balloons of water filled with warm air. As the cloud particles grow to raindrop or snowflake sizes their rate of fall increases greatly, to four or even nine meters per second for medium and large sized drops and to one meter per second for snow.

When they first form, clouds are usually composed of liquid droplets no matter how low the temperature. This seems to be because of the presence of hygroscopic nuclei in the air. At low temperatures, however, ice crystals soon begin to form, apparently on other nuclei. The attraction of ice crystals for molecules of water is appreciably greater than that of liquid droplets at low temperatures; so, the ice crystals will grow more than the droplets. In fact, they will reduce the number of molecules in the air to such an extent that the droplets will evaporate. Thus a cloud of liquid droplets may transform into one of ice crystals. The number of nuclei on which ice may start to form is many times less than the number of hygroscopic nuclei for the formation of droplets, so after the transformation, the individual crystals will be considerably larger than the individual droplets were. This makes the crystals fall much faster, and is responsible for the delicate, hair-like lines so characteristic of the highest clouds, the cirrus clouds.

It is generally readily possible to tell whether a cloud is composed of liquid droplets or of ice crystals. The liquid clouds are usually dense, have sharp outlines, and exhibit more or less regular rings of color close about the sun or moon. These colored rings are called coronas. They are caused by the physical process called diffraction. Diffraction is the bending of the waves of the light rays of different colors as they pass around the cloud droplets, and then the interference of these bent waves in such a way that at one angular distance the sets of one color are out of step and so extinguish one another, while at the same distance the sets of another color are in step, and so make that color strong just where the other color, that might have neutralized it, is not present. The rings of color we see are generally only a few degrees from the sun or moon, and blue is on the inside.

The purer the colors, the more nearly are the cloud droplets of the same size. And the smaller the rings, the larger are the drops. When clouds having small drops in one part and large ones in another, owing to diverse vertical motion or unequal age, come near the sun or moon, a variegated pattern of mixed portions of coronas may result. This is called iridescence. At times this may give a beautiful display out to 20 or even 30 or more degrees from the sun—usually in cold weather or on high clouds, when the droplets are small.

An ice cloud is usually thin, fibrous and hazy in outline. The refraction of light as it passes through the ice crystals often produces a prismatic effect in the form of a circular halo. The halo is usually 22 degrees, or the span of an open hand at arm's length, out from the sun or moon. Since in refraction the longer

Cirro-stratus, ribbed: precursor of a storm. View WNW from Blue Hill, May 18, 1938, 11:54 a.m.

Fair weather cumulus formed over the land. Photo by Julian A. Dimock.

waves are bent least, the halo is red on the inside.

The forms of clouds depend on their mode of formation. Thus, their forms can be used to tell what is going on. All clouds result from the cooling of moist air. The cooling may result from mixing of warmer with colder air, from radiation, or even from conduction of heat to rain or snow; but the cooling is usually caused by expansion of the air as it ascends from levels where the pressure is higher to those where it is lower. This ascent, when it takes place in the form of bubbles or columns of warm air, results in the formation of lumpy clouds, called cumulus. When, however, it is the ascent of a broad layer of air, as over a mountain range or an obstructing mass of colder air, the cloud form resulting is a sheet cloud, stratus.

There are many combinations of the cumulus and stratus forms, when, in a rising sheet, there is also some localized up and down motion. At low levels the resulting lumpy sheet cloud is called strato-cumulus; at middle levels, alto-cumulus, and at high levels, cirro-cumulus. The distinction between these forms is simply on the basis of the apparent size of the smaller cloud units, except in the case of the cirro-cumulus, where, on account of the great height and extreme cold at its levels, a certain amount of snowiness, the cirrus cloud, usually is to be seen with the lumps.

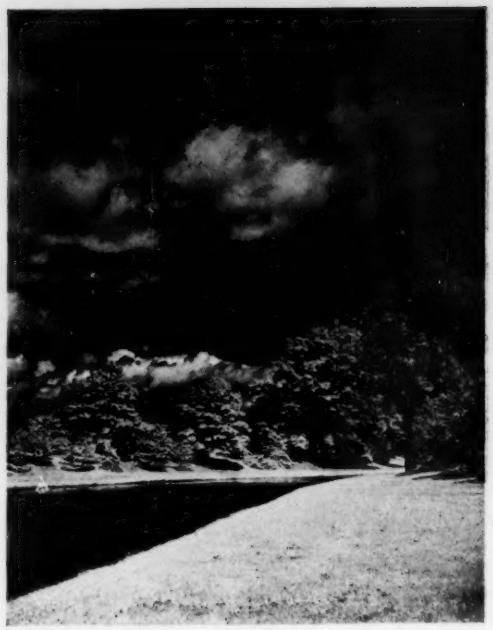
When the process of cooling in ascent has lowered the temperature of a cloud considerably below the condensation point, larger particles that have grown within the cloud begin to fall out, usually in the form of snow or rain. The resulting appearance of streaks of falling precipitation is known as virga. Cirrus clouds are thin virga high in the atmosphere. When the cirrus virga becomes extensive over the sky it is called cirro-stratus, that is, while it is still thin enough to produce a halo. When the cloud of falling snow becomes thicker, and begins to look grayish, it is called alto-stratus. The sun may appear blurred or disappear altogether. Thicker still, as when the snow is about to reach the ground, it becomes nimbo-stratus. Often the falling snow turns to rain at a height of one to three miles, in which event the falling streaks may look thinner and darker, yet will still be called nimbo-stratus.

When an ascending column of warm moist air is very large and continues for a matter of half an hour or more, a huge columnar cloud will be formed, that will spread out at the top and produce heavy rainfall, usually accompanied by lightning and thunder, and sometimes by hail. This is the cumulo-nimbus, or thundercloud. It is sometimes called a cloud factory, because all the other cloud forms may be associated with or come from it.

I have now named and explained the 10 cloud forms that are recognized the world over. They look the same in South America as in North America, and are caused in the same way. The only differences are that in the tropics and in the warmer seasons the clouds of the same name are higher by a mile or two, and the forms with vertical development, cumulus and cumulo-types, are more common.

The aviator learns in the forms and sequences of the clouds how to recognize bad flying weather before he may get caught in it. Others may do the same, in fact, in these days of information restricted by war secrecy, each must be his own forecaster. A study of the clouds, therefore, is very helpful. Thickening clouds precede rain, but if the thickening is more or less hesitating one can conclude

Strato-cumulus clouds with virga—incipient snow flurries of an early spring afternoon. View west from Blue Hill, March 18, 1941, 4:35 p.m.



Infrared light penetrates clouds, and makes possible a study of their structure. *Left:* Photograph with ordinary film under normal conditions. *Right:* Photograph with infrared film through a red filter. Note the detail in the heavy bank of distant cumulus.

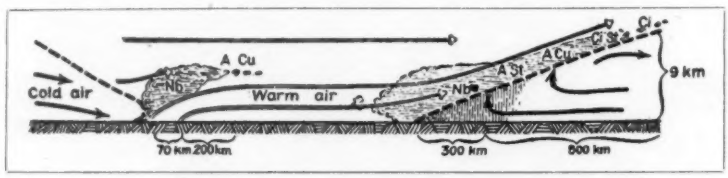
that the storm is either not particularly strong or else is not heading directly his way. The rates of cloud movement, especially of middle levels, show how fast a storm may be approaching, and their motion indicates the direction the storm is coming from. Fast movements of the highest clouds accompany rapid weather changes.

An example or two may be given. At a place in middle latitudes, the first signs of an approaching general storm are the wisps or hooks of cirrus appearing in some westerly direction. These mark the forward extent of a moist wind high aloft. As the cirrus join and thicken into cirro-stratus, we have further evidence of the thickening of the moist air mass and the cooling process it is undergoing, as it rides upward on a long incline over the colder air mass below.

As the moist air mass wears its way downward and occupies a thicker layer, the cirro-stratus darkens into alto-stratus and finally nimbo-stratus, when rain or snow begins. The raindrops or snowflakes, by chilling and humidifying the lower air, usually make the turbulence near the ground visible in the form of low, fracto-cumulus clouds.

The passing of the first phase of the storm is marked by a clearing of the sky, and a sharp rise in temperature, as the arrival of the so-called warm front marks the final establishment of the warm air mass all the way down to the ground.

Passing showers may now occur, succeeded by a thickening of the western sky with heaped-up clouds that indicate the approach of the cold front, where the cold air mass on the rear of the storm is invading the territory held by the warm air mass. The cold air mass lifts the warm, thereby exposing it to lower pressures which allow it to expand and cool internally, which usually produces dense clouds and a sharp shower as well.



The vertical cross-section of a storm. The arrows indicate the directions of motion of the air masses, so the sequence of events at one station is from right to left across the diagram. Cloud types are indicated by abbreviations. From U. S. Dept. of Agriculture, *Misc. Pub.* #236.

Alto-cumulus near sunset. What meteorologists call a "lateral sky," quite a distance from the center of a storm.

Thereafter, the clouds pass off to the east, and the last stage, as fair weather becomes established, is a bank of high clouds low in the east, while friendly cumulus clouds, formed in air ascending from locally heated or humidified spots, dot the sky with their white cottony masses.

At the Hayden Planetarium

Starting on April 13th and continuing through May, *Weather Signs in the Sky* will be the subject of the Hayden Planetarium demonstration. Next month *Sky and Telescope* will carry an article on this subject by William H. Barton, Jr.

NEWS NOTES

By Dorrit Hoffleit

RADIOGRAM FROM MARSEILLES

A radiogram was received at Harvard College Observatory on February 10th announcing the discovery by R. Jonckheere, of the Marseilles Observatory, on January 18th, of an "etoile rouge remarquable," 9th magnitude, at 6h52m.5, 6°27'.5, "spectre desire."

A spectrum plate obtained at Harvard on a red-sensitive emulsion indicated an *Nb*-type spectrum. (Mt. Wilson observers in 1933 and Dearborn observers in 1940 had already classified it as *N*.) This type, always representative of cool, red stars, is characterized by absorption bands due to carbon molecules.

Chart photographs obtained on February 10th on red-sensitive plates showed a comparatively bright star, which was entirely invisible on photographs secured the same evening with ordinary blue-sensitive emulsions.

Since stars with *Nb* spectra are generally variable, all the available Harvard photographs were examined in the hope of finding changes in the brightness of the star. Twenty photovisual plates (emulsion most sensitive to yellow light) showed a variation between magnitudes 9.4 and 12. One hundred ordinary (blue-sensitive) plates exposed between 1897 and 1942 indicated fluctuations from 13.5 to fainter than 16. Thus the star is photographically about four magnitudes fainter than it appears to the eye. Although the fluctuations in brightness are not uniformly periodic, the times of maximum brilliance are roughly separated by 500 days.

A search through variable star literature then revealed that the star had already been discovered as variable in 1931 by Hoffmeister in Germany, who examined 14 plates taken between 1928 and 1931. But the following year, Parenago, in Russia, seeking to confirm the variability, found that the star was invisible on all (15) of his plates. Hence the variable was deprived of official sanction: it was cubbyholed in a list of suspected variables instead of being given a designation in the *Katalog und Ephemeriden Veraeanderlicher Sterne*, the official "Who's Who" among variable stars.

The telegram from Marseilles thus instigated the coordination of miscellaneous bits of information on a most interesting star. Of great significance, however, is the fact that an occasional astronomical telegram still, unexpectedly, finds its way across the turbulent oceans.

A SATURN-LIKE STAR

One member of the double star system, RW Tauri, viewed at a distance of a billion miles, would appear very much like Saturn seen through a small telescope, according to Dr. Alfred H. Joy, of Mt. Wilson Observatory. The star is intensely hot and surrounded by a luminous ring of gas about four times the diameter of the sun. The ring, revolving around the star at the rate of 800,000 miles an hour, completes a revolution every 14 hours. The Saturn-like star is eclipsed every 66 hours by the other member of the binary system, a star much like the sun. Evidence for the luminous ring was found through an analysis of the variations in the total amount of light received from the system.

The ring is composed of glowing gases of hydrogen, magnesium, calcium, and iron.

. . . AND THE WAR

The staff of the South African station of the Harvard College Observatory is not large, but it has contributed at least four members toward the Allied war efforts. A former chief assistant is now a major of artillery serving in northern Africa. He was awarded the Military Cross in recognition of noteworthy activity in southern Abyssinia. Another member of the staff is an officer in one of the prisoners camps in South Africa. A third is serving with the military police in North Africa, and the fourth is a private in a military transport.

Visitors' Nights at the Lick and Mt. Wilson Observatories have been discontinued on account of the danger of blackouts; but visitors are still admitted daytimes at scheduled hours as in the past. Mt. Palomar has been closed to visitors entirely. The astronomical programs of the observatories of the West Coast are, however, being carried on very much as usual, even though many of the staff members are on leaves of absence for defense work.

METEORITE EXCAVATING

The second largest meteorite crater in the United States, near Odessa, Tex., is being excavated under the direction of Dr. E. H. Sellards, of the University of Texas. It is 500 feet in diameter and 50 feet deep. The principal mass of meteoritic material is some 170 feet below the original ground surface. Near the large crater two smaller ones were discovered last autumn, the larger of the two being 70 feet across and 17 feet deep.

All three of the craters are believed to have been formed about 40,000 years ago. Great age is proved by the discovery, in the main crater, of teeth and bones of an ancient type of American horse which became extinct long before the introduction of Spanish horses into this country.

THE NEAREST STARS

Dr. G. P. Kuiper, of Yerkes Observatory, has made a study of all the known stars nearer than about 35 light-years (254 stars). There is a striking difference in the array of characteristics found for the bright naked-eye stars and those for the stars that are our nearest neighbors in space. A large percentage of the naked-eye stars are either highly luminous, hot blue stars, or cool giant or supergiant yellow or red stars. Very few such stars are as close as 35 light-years—only one giant, Pollux, and four bright (main sequence) blue stars. Among the nearby stars, on the other hand, we find seven white dwarfs, all of them faint telescopic objects, as well as the numerous normal yellow and red dwarfs.

To the naked eye, the nearby stars are not generally bright; only 36 of the 254 are brighter than the 5th magnitude. This is so because there is a ratio of over 100 million to 1 in luminosity between the intrinsically brightest and faintest stars known, the faint stars being cosmically in the majority, even though very difficult to discover. Practically all stars brighter than 1/100 the sun within 35 light-years are known, whereas half of those 1/1,000 as bright and 90 per cent of those 1/10,000 as bright as the sun still remain to be discovered.

From his study of our recognized neighbors, Dr. Kuiper concludes that our sun, a dwarf star (faint among the average naked-eye stars) is really bright compared with the general run of the stellar population. On the assumption that there are no stars fainter than absolute magnitude 17, he finds that only five per cent of the stars are intrinsically brighter than the sun, 95 per cent are fainter.

Another interesting conclusion reached is that over two thirds of the stars that are more massive than the sun have split into double or multiple stars, a result of significance to any theory of stellar evolution.

ANOTHER RADIOGRAM

As these notes go to press (March 16th), a radiogram is received via Sweden reporting the discovery by Y. Vaesaelae, of Turku, Finland, of a fast-moving object of the 13th magnitude, stellar in appearance, positions:

March 12, 0h 26m U.T.; 10h56.1m, —0° 23'.
March 13, 18h 35m U.T.; 11h1.3m, —3° 25'.

Weather conditions are interfering with its confirmation at Harvard, but many other observatories have been notified.

MORE ASTRONOMICAL LITERATURE FROM EUROPE

Bulletin No. 4 of the Committee for the Continued Distribution of Astronomical Literature reports on recent publications by astronomers in belligerent European countries. German journals contain investigations on wave mechanics and on the aberration of light, perturbations of asteroidal orbits, color indices of planets, the brightnesses of minor planets, the deflection of light around the sun, spectroscopy of the solar corona, and the theory of chromospheric eruptions. The subject matter of papers by Italian astronomers includes stellar spectroscopy, the determination of radial velocities, variable stars, occultations of stars by the moon, observations of comets and of Eros, celestial mechanics, and astronomical determinations of terrestrial positions.

Although current records of librarians indicate an almost complete cessation of receipts of publications from Europe (except England), the efforts of this committee have resulted in satisfying evidence that astronomy is still actively pursued in war-infested Europe.

BEGINNER'S PAGE

By Percy W. Witherell

The Eleven Moons of Jupiter

THE world was aroused from its mental complacency in 1610 by Galileo's discovery of the four large satellites of Jupiter with his small, primitive telescope. (See *Sky and Telescope*, January, 1942.) The Galilean moons range in diameter from that of our moon to that of the planet Mercury, and are bright enough to be seen by the naked eye, if they were not overwhelmed by the glare of their master.

Io (*I*), Europa (*II*), and Ganymede (*III*) are probably rock and have no atmospheres. Callisto (*IV*) has a specific gravity of only 0.6 and may be frozen water, hydrogen, and ammonia. They all revolve in the equatorial plane of Jupiter in 1¾ to 16⅔ days, keep the same side toward the planet, as our moon does to the earth, and are at reasonable distances of ¼ to 1¼ million miles from its center. That their predicted movements are recorded in 26 pages of the 1942 *American Ephemeris and Nautical Almanac* shows their value in navigation.

One very interesting result from the constant study of the period of rotation of the satellites was the first determination of the speed of light. In 1675, Roemer noticed a difference of 16m 37s in the computed and observed positions of the satellites when the earth was on opposite sides of its orbit, from which he deduced a speed only a little larger than the present value of 186,270 miles per second.

So, the astronomical world was satisfied to record the numerous eclipses, occultations, and transits of these large satellites and to calculate their masses, periods, and positions, until 1892.

In that year, Barnard, after a careful search for two months with the 36-inch refractor at Lick Observatory, was rewarded with the discovery of the satellite *V*. This inner satellite of about 100 miles' diameter rushes around Jupiter in less than 12 hours at the terrific speed of 58,000 miles per hour, and at only 68,200 miles from the surface of the planet. This was the last satellite in the solar system to be discovered visually.

In 1904, Perrine discovered *VI*, and in 1905, *VII*, on photographic plates taken with the Crossley reflector at Lick, and in 1938, Nicholson found *X* on plates taken by long exposures with the 100-inch reflector at Mt. Wilson Observatory. These three form a group about 7,000,000 miles from the planet and take a little over 250 days to complete their trips around their orbits.

All of these moons move in their orbits in the same direction as the planets around the sun, and although they are very small (10 to 100 miles in diameter, and consequently so faint as to be discovered only by powerful photographic methods), everything in the solar system was "according to Hoyle," except for tiny Phoebe, which Pickering had discovered in 1898 going around Saturn in an orbit so inclined to Saturn's plane that it appeared to go in a retrograde direction.

However, in 1908, Melotte photographically discovered *VIII* at a distance of 14,600,000 miles from Jupiter's center and taking 738 days to complete its circuit, and what was more extraordinary, it was going in the opposite direction to all the others.

In 1914, Nicholson discovered *IX* while studying plates taken at Lick to compare the observed and calculated positions of the satellites. This also moved in a retrograde direction in 760 days at about 15,000,000 miles from the planet.

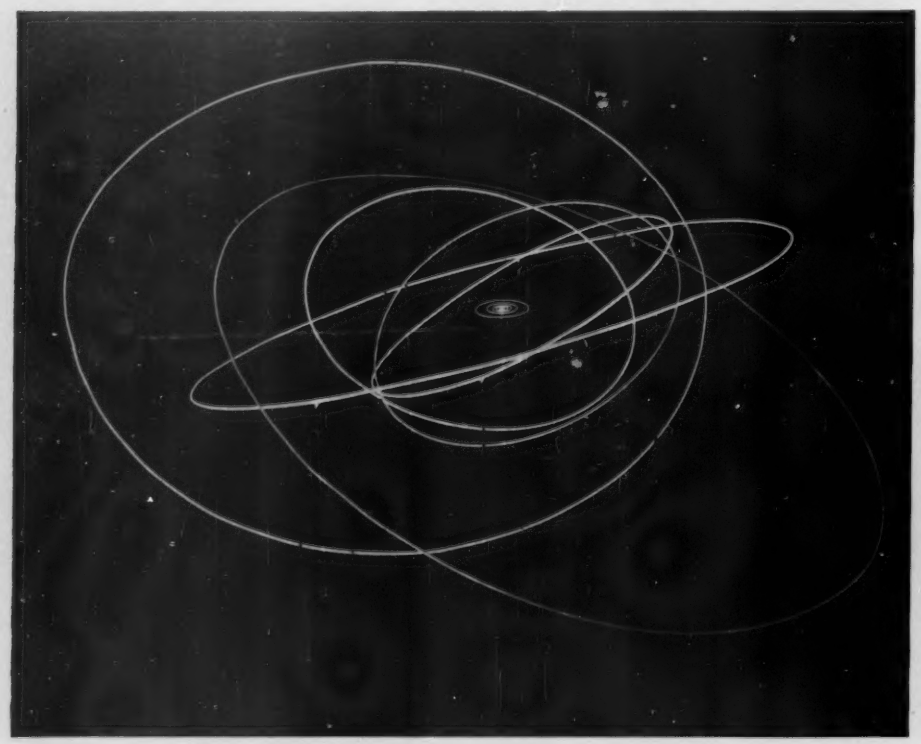
In 1938, Nicholson made a systematic search with the 100-inch and discovered not only *X* as mentioned above, but also *XI*, which belongs in the 14,000,000-mile and 700-day-retrograde group.

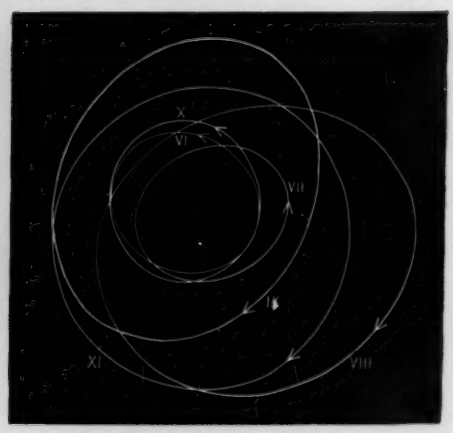
This search shows the exactitude required to discover such faint objects. The plates reached magnitude 20. The telescope was kept on Jupiter, so that the stars were recorded as elongations, and the satellites as dots, as they moved only

THE SATELLITES OF JUPITER

	Discoverer	*Year*	*Mean distance, miles*	*Sidereal period* d. h. m.	*Diameter, miles*	*Stellar mag.*
V.	Barnard	1892	112,600	11 57	100	13.0
I.	Galileo	1610	261,800	1 18 28	2320	5.5
II.	Galileo	1610	416,600	3 13 14	1960	5.7
III.	Galileo	1610	664,200	7 3 43	3200	5.1
IV.	Galileo	1610	1,168,700	16 16 32	3220	6.3
VI.	Perrine	1904	7,114,000	250 14 40	90	13.7
VII.	Perrine	1905	7,292,000	260 1 24	25	16
X.	Nicholson	1938	7,350,000	260	10	18.8
XI.	Nicholson	1938	14,040,000	650 *	10	18.4
VIII.	Melotte	1908	14,600,000	738 21 36*	25	17
IX.	Nicholson	1914	14,880,000	760 *	19	18.6

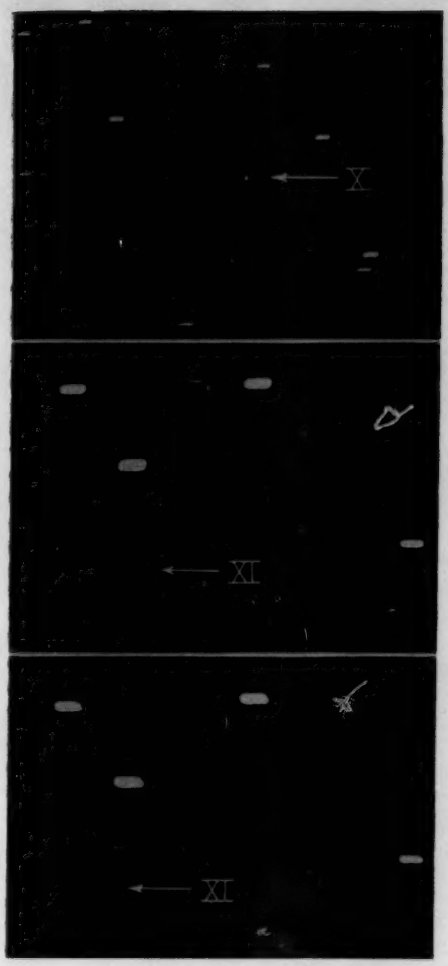
*Retrograde.





Two photographs of a model of Jupiter's satellites, constructed by Dr. Seth B. Nicholson, of Mt. Wilson, at the time of his discovery of *X* and *XI*, to show the amazing complexity of the outer orbits. *Left:* The inclinations of the orbits show when the model is photographed at an angle. *Below:* The orbits are numbered and the direction of motion shown on this photo taken as though seen from the planet's pole.

Amateur Astronomers



The most recently discovered satellites of Jupiter, *X* and *XI*, photographed with the 100-inch telescope. The lower pair of pictures shows the motion of *XI*. The stars in the field appear as streaks. Mt. Wilson photographs.

slightly relative to Jupiter in the one-hour exposure and so left visible images.

Asteroids were troublesome, but could usually be eliminated, as they generally appeared to travel faster than Jupiter (they are nearer to us) and so made slightly elongated images. About 40 moving objects were recorded on the plates. After the asteroids and *VI*, *VII*, *VIII*, *IX* were identified, there remained five moving objects to be considered. Three were finally proved to be asteroids which happened to be nearly in line with Jupiter, and so appeared for a few days to move at the same speed as the planet. This left *X* and *XI* as new discoveries.

The members of this distant group are so small and so far from Jupiter, and so exposed to the gravitational pull of the sun, that their orbits are very eccentric and are probably not completed curves.

Herget has shown recently that the node in the orbit of *XI* shows an irregular advance of an average of four degrees per year, and that the eccentricity of the orbit ranges from 0.14 to 0.37.

Were these objects captured by Jupiter as his family of comets was, and will he be able to retain them against the wiles of Old Sol? These are questions for the future to answer.

DETROIT LAYS PLANS

PLANS for the convention of amateur astronomers, to be held on July 4th weekend in Detroit, are going forward under the sponsorship of societies in and near that city.

It is hoped that this will be the first convention of the Amateur Astronomers League of America, as well as the fourth annual convention of amateur astronomers. Experience gained by the three preceding conventions, held respectively in New York, Pittsburgh, and Washington, should help make this coming July 4th weekend valuable and entertaining.

The Rackham Educational Memorial Building, in which there will be registration, some meetings, and the exhibits, is a magnificent white marble structure, dedicated, in February, to the advancement of education in Detroit. It is conveniently located in the Art Center. We feel that we have been greatly privileged in being granted lecture and exhibit rooms in this building.

Speakers tentatively scheduled for the convention are Dr. Robert R. McMath, director of the McMath-Hulbert Observatory, who will show some of the famous solar films taken at that observatory; Prof. W. Carl Rufus, of the University of Michigan; Prof. Everett R. Phelps, of Wayne University, who will lecture on celestial navigation.

Talks by the amateur exhibitors, and a discussion of problems met with in astrophotography are planned, in addition to the official business session on matters regarding organization of the League.

There is much of astronomical interest at the Cranbrook Institute of Science, near Lake Angelus, to which a trip is planned. A 6-inch refractor is available, and on display will be an ancient Gregorian telescope, a model of solar prominences, a small planetarium, meteorites, and tektites.

The University of Michigan has offered to provide a local committee to take charge of our visit to Ann Arbor, where we hope to obtain permission to use the spectroheliograph as well as the telescope which is used for observation.

We have had to rearrange our program very considerably due to telephone communications recently with Dr. McMath, who is sorry to state that the Government is using the McMath-Hulbert Observatory for research, and the public is not allowed anywhere near.

The May issue will contain more news pertaining to accommodations and travel. Meanwhile, it is not too early to begin planning so that you and your family can attend the Detroit convention. As a preliminary survey, please send a postcard to the undersigned signifying your intention—as far as you know it at present—of attending, and also the names of your family or friends who might accompany you. Such a survey will aid materially in completing arrangements for an instructive and entertaining time.

MARGARET BACK, secretary
Northwest A.A.S. and Detroit A.S.
1483 Iroquois Avenue
Detroit, Mich.

AMATEUR ASTRONOMERS ASSOCIATION
New York

Fourth Annual Dinner, Wednesday, April 1st, 7:30 p.m. The A.A.A. will celebrate its 15th anniversary on this occasion. Astronomically prominent guest speakers will give short addresses, and there will be novel entertainment and music. Reservations at $1.65 per person should reach the secretary by March 28th. The dinner will be held at the Brewster Hotel, 21 West 86th Street, New York City.

Prodigal Suns is the subject of the lecture by Dr. Roy K. Marshall, of the Fels Planetarium, at the regular meeting of the A.A.A. on April 15th, in the Roosevelt Memorial Building of the American Museum of Natural History. This meeting begins at 8:15 p.m., and is open to the public.

Field Trip to Sproul Observatory, Swarthmore, Pa., on the weekend of April 25th. Interested persons should communicate with the secretary, George V. Plachy, for further details.

DULUTH A. S. RATIFIES BY-LAWS

The eleventh society to ratify the by-laws or propose conditions necessary for final ratification of membership in the Amateur Astronomers League of America is the Duluth (Minnesota) Astronomical Society.

Secretary W. S. Telford sent in a letter containing the payment of the initiation fee in advance.

A complete list of proposed changes in the by-laws is being compiled, and will shortly be sent to the 11 societies for further consideration. Meanwhile, all other groups are urged to consider membership in the League immediately, in order that they may take part in drawing up its final by-laws and in proceeding with its organization.

STELLAFANE CANCELLED FOR 1942

Due to the drive of war work here that calls for all machine tool plants to operate seven days per week and all holidays, and also the probable lack of gasoline and tires, and the shortage of rooms, and so on, we have very reluctantly decided to give up the convention of telescope makers this year at Stellafane.

We are very sorry to have to come to this decision, but we could see no way of holding the convention and at the same time all doing their part toward winning the war.

We hope that you may be able to make this decision known to your readers through the columns of *Sky and Telescope*.

ROY J. LYON, secretary
Springfield Telescope Makers

GLEANINGS FOR A. T. M.s

EDITED BY EARLE B. BROWN

THE A.T.M. AND THE WAR

WHAT effect the war is having and will have on the activities of the amateur telescope making fraternity is a matter worthy of some consideration. That it will result in a curtailment of telescope construction is not open to doubt. Due to the demands of war production for aluminum, steel, brass, and other metals, any amateur telescope making which goes on will be of a makeshift character for the duration. Fortunately, there is at present no critical shortage of glass, although one has no assurance how long this will continue to be true.

But it would be a catastrophe if A.T.M.s were to permit this temporary situation to cool their enthusiasm. Those who already have telescopes will now find the time to put them to practical use. While it is not true in every case, it is all too often true that excellent amateur-made telescopes lie idle while their owners struggle in the workshop with new designs and new ideas. Now is the time to start putting these instruments into operation, piling up the thousands of observations which are going to be important to astronomy a few years from now. For celestial events are quite above earthly conflicts, and must be continually followed, else there will be an unforgivable gap in our astronomical records.

Now, also, is a good time to bring up our pet peeve. Too many amateur telescopes are made piecemeal, and the builder has no idea what his instrument is going to be like until he has finished it. A telescope should be carefully designed, from stem to stern, before carborundum is ever sprinkled on a tool. Before the building of a telescope is undertaken, both the optical system and the mechanical design should be thoroughly sketched out on paper. Consideration must be given to such questions as aperture, focal length, field of view, light grasp, resolution, magnification, cost, portability, and so on. If the builder carefully plans his instrument, not only in his mind, but on paper, his results will be immeasurably more satisfactory. And now that construction must be curtailed because of shortages of material, this is an unparalleled opportunity for the A.T.M. to spend some time at his desk and make computations and drawings of the telescopes that he will get under way after the war.

There will be a mine of information after the war for A.T.M.s, in the line of special developments in the optical field. But, for the most part, these developments are in the character of confidential military information at the present time, and disclosure must wait.

It would be interesting to know to what extent A.T.M.s throughout the country are making use of their special knowledge and skill to help out in the war. The optical industry is a particularly vital one in wartime, and many amateurs have sufficient ability and experience to be very useful. No less than 14 of the New York group are known to have entered the optical field professionally. No doubt the proportion is general over the nation, and we should enjoy a few reports from here and there on the subject.

As this is written, we receive word that the annual pilgrimage of telescope makers to Stellafane will not take place this year, due to the pressure of war work on members of the Springfield Telescope Makers. (See page 19.) Springfield, Vt., may be the cradle of modern amateur telescope making, but it is also a cradle of the all-important machine-tool industry.

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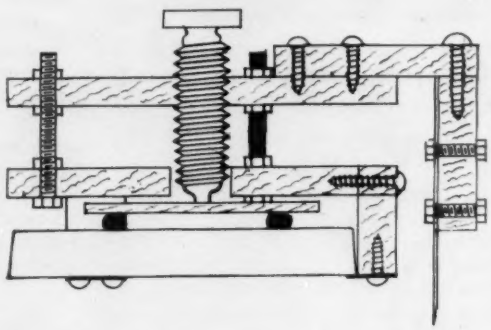
WOODEN CELL

R. S. Luce, of the New York Optical Division, has developed a wooden mirror cell similar to the design described here in The SKY, April, 1941. This wooden cell, to be used temporarily for the duration, retains all the features of the aluminum one, but contains only the metal in a few bolts and screws. It can be made with a minimum of tools.



REPORT ON A SCHUPMANN

H. S. McClung, of Regina, Saskatchewan, is the first to report to us on the construction of a Schupmann telescope. He writes: "I built a Schupmann telescope of 3¼" aperture by 45" focus. I calculated my corrector for 22", using for both objective and corrector glass from a sheet of commercial plate. The chromatic error is nicely corrected but I get multiple images either in my shop with an electric lamp as an object, or outside on celestial objects." In a later letter, "I read a note in *Science News Letter* regarding the action of fluoric acid in creating a non-reflecting surface on glass. This suggested to me the cure for multiple reflections. So, working with the professor of chemistry in our university here, we tried this process. Our technique must have been faulty or the glass was not a calcium glass, for we did not then get good results. We are going at it again soon, and may have a better report later."

As we pointed out in the Technical Bulletin relative to the Schupmann, this telescope is an excellent candidate for treatment of surfaces to reduce reflectivity. Mr. McClung's experience seems to indicate that this is a necessary operation in the case of the Schupmann, although it would be premature to conclude that it is impossible to make the design operate satisfactorily without such treatment. However, there is no doubt that, within a few years, all optical instruments will be so treated as a matter of course.

GLEANINGS is always open for comments, contributions, suggestions, and questions, from its readers. We are here to serve, in every possible way, those of the telescope-making fraternity who are among the readers of *Sky and Telescope*.

ASTRONOMICAL ANECDOTES

A REVERSED SCHMIDT, PATENT 969,785; AND ZEPPELINS

ASTRONOMY occasionally has something to contribute to man's activities in other lines. Everyone is by now familiar with the application of the Schmidt-type camera in the armed forces, but it may not be so commonly known that in the field of television the same device also finds a practical use. Serious problems are involved in the projection of large television pictures, as for example in a theater. The illumination of the sensitive receiving surface can be made high only through multiplicity of electron impacts, and these produce intense heat, as well. It has been impracticable with earlier optical systems to obtain "fast" enough projectors.

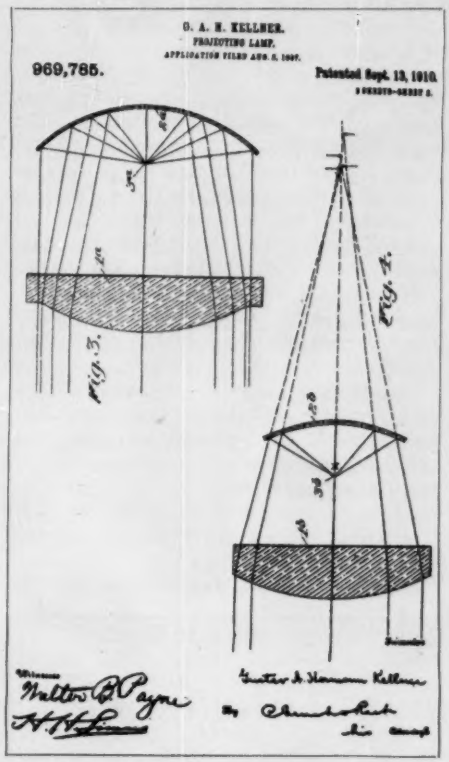
For television use, the Schmidt-type camera is reversed, and made a projector, by putting the tube in which the image is formed in the position where one usually finds the sensitive film. The picture faces away from the screen, of course, and is picked up by the mirror, reflected through the thin lens or correcting plate, and falls on the screen. There are many difficulties involved, over and above those encountered in the usual design, because these projectors must be designed for finite throw, and are not suitable for taking celestial photographs, of objects at infinite distance.

But the use of a Schmidt-like system in projection of light outward from the focus goes back to rather early days. The research men who have been busy at this new television application have been kind enough to tell me about a patent which I believe should be known to everyone interested in the development of Schmidt-like optical systems.

The patentee is Gustav A. Hermann Kellner (of eyepiece fame), and U. S. Patent No. 969,785, assigned to the Bausch and Lomb Optical Company, was granted September 13, 1910; it had been applied for August 2, 1907. It is "A Projecting Lamp."

"This invention has for an object to provide a lamp in which the lens and the reflector are so formed and so arranged relatively to the light source that the reflected rays issue from the lens parallel to the optical axis and thereby produce a condensed and powerful beam," states the patent. "Figure 3 is a view of the optical parts of a lamp in which a lens with spherical aberration corrects a reflector. . . . In this form I employ a spherical mirror or reflector which, as is well known, is spherically under-corrected and combine therewith a lens which is spherically over-corrected; in other words, the lens and the reflector have spherical aberrations of opposite signs and preferably like amount so that the marginal rays of the lens focus at the focal point of the optical combination. . . ." He then proceeds to give the equation of the correcting lens.

It will be noted that there is no claim that this same type of system could be used in photography, yet it is strange that Kellner had not thought of it, or someone else at Bausch and Lomb. For that matter, why did no one even earlier, for example after seeing what could be done with



short-focus instruments such as Barnard's portrait lenses, or the Yerkes 24-inch and the Crossley 36-inch reflectors, suggest that faster optical systems should be devised? It certainly must have been an elementary matter, as soon as spherical aberration was discovered, to realize that if a system exists which has too little compensation for spherical aberration, it should be possible to have one which is overcorrected, and a combination of the two would make an aberrationless system.

Every amateur telescope maker knows that he can't use a spherical mirror (unless of very long focus), because a sphere is undercorrected for spherical aberration; he must take care not to get a hyperbolic mirror, for it is overcorrected. So another of Kellner's designs, in the same patent, involves a hyperbolic mirror with a correcting lens of spherical curvature. Several other suggestions and worked-out numerical examples are also included, some of them involving "refraction mirrors," that is, back-surfaced mirrors of appreciable thickness, through which the light would be refracted, both before and after reflection.

It is tempting to suggest that in the future no one will have occasion to complain that we have overlooked something, except the employment of glasses of indices of refraction two or three times as high as any we today possess. In the recent wave of popularity which swung the Schmidt-like system to its supreme position, so many workers, practical and theoretical, have taken part, that it seems very little can have been overlooked. To be sure, some of the systems are ideal but impracticable, but they might not be so with new kinds of glass. It has been some time since anything new along that line has been put into practical service.

I have recently been reading some old issues of the excellent British weekly, *Nature*, and back about 1916 there was considerable discussion of the formulae for the glasses then being made in Germany. But another contribution to warfare, by an astronomer, caught my eye. In Volume 97, page 221, under the title "Avoiding Zeppelins," and over the date April 10, 1916, there is this communication:

"There is no danger from a bomb dropped by one of these vessels unless the latter is approaching the zenith, and will reach there in a few seconds. If the Zeppelin appears inclined—that is, unless one end appears exactly over the other—there is no danger. . . . The Zeppelin will always pass over the point towards which the upper end points. . . . It is only necessary to run at right angles to the apparent direction of the Zeppelin to be safe. . . ."

The communication is signed by E. C. Pickering! R.K.M.

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BOOKS AND THE SKY

MANUAL OF ASTRONOMY

R. W. Shaw and S. L. Boothroyd. Cornell University, Ithaca, N. Y., 1941. 305 pp. $3.00.

THIS laboratory manual of astronomy, prepared by two well-known professors of astronomy at Cornell University, contains 44 exercises divided as follows: eight on stars, five on planets, three on the sun, six on the moon, four on time and position, four on meteors, three on clusters, five on instruments, five on spectra, and one on nebulae. About half of these exercises do not require special equipment nor data beyond that presented in the *Manual;* another six require only a very limited amount of equipment. The book is therefore well suited for use at small colleges with limited equipment, as well as at the larger institutions. It is pleasing to find a considerable number of exercises suitable for cloudy evenings when celestial observation is impossible.

Considerable emphasis is placed on basic elementary exercises such as learning the constellations, telling time from the stars, observations with binoculars, visual observations of the planets, observing the moon, observing meteors, and so forth. One is inclined to agree with the authors that the student should retain his *Manual* on completion of the course; no book is ever so satisfactory as when it contains one's own notes and observations.

It is obvious that the *Manual* was prepared in time of peace, for there is no mention of the sextant, the vernier, comparison of watch with chronometer or chronometer with radio time signals—exercises which are desirable today for a student who may soon be training as a navigator for the armed forces of the nation. This deficiency is minor, and easily remedied by the individual instructor.

It is encouraging to discover a book such as this, generously supplied with maps, tables of data, cross-section papers and diagrams; it promises well for the continuance of high standards of teaching of astronomy in American colleges and universities.

CHARLES H. SMILEY
Ladd Observatory

JEAN DOMENIQUE CASSINI AND HIS WORLD MAP

Lloyd A. Brown. University of Michigan Press, Ann Arbor, 1941. 79 pages. $5.00, including large map.

CASSINI'S *Planisphere Terrestre* was once referred to as "the first scientific map of the world." Generations of map makers, and especially the notable efforts of Regiomontanus, Columbus, Magellan, and Mercator, lie in the background of the story of this map. It grew, however, out of the efforts of the Academie Royale des Sciences to find a practicable method of determining longitude.

By 1670 Jean Picard had completed his well-known meridional survey. Nearly a century before the perfecting of the marine chronometer by Harrison, the Academie was sponsoring a program of determining longitude by observations on the eclipses of Jupiter's satellites, a method which was gradually replacing older and clumsier ones, which had involved either lunar distances from stars, or lunar eclipses. The author might have dwelt a little more on Galileo's work in this connection. Needless to say, the advent of radio time signals now makes all these methods quite obsolete.

The pioneering in longitude determination was of immense value to map makers. One of the first to make cartographic use of the new information was Cassini (1625-1712), who joined the staff of the Paris Observatory in 1669 after a distinguished astronomical career in Italy.

From 1672 to 1679, Cassini worked painstakingly on a map of the moon's topography. In 1680, he conceived the idea of a large-scale map or planisphere of the world. Under his direction, this was executed in ink by Sedileau and de Chazelles on the third floor of the west tower of the Paris Observatory. The map itself, which was laid down on a north polar projection, was about 25 feet in diameter. The original faded from the floor, but copies were made on paper. The earliest known publication of the *Planisphere* is the Nolin Imprint, a copy of which was recently turned up in the Clements Library of the University of Michigan.

In view of the recent determination by the Astronomer Royal of the distance of the sun as almost exactly 93 million miles,

An Introduction to Television

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Mr. Hylander, who has written many successful books on science for young people, and Mr. Harding, formerly of the National Television Company, are well equipped to present this interesting subject. Many photographs and diagrams. $2.00

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it is timely for this reviewer to mention that, as Brown points out, Cassini deduced from his observations and those of Richer and Flamsteed on Mars, a value of 87 million miles. This was a considerable improvement on the then currently accepted value of 14 million miles for the astronomical unit.

Students of the history of science will appreciate this little monograph linking together geography and astronomy.

RALPH S. BATES
Massachusetts Institute of Technology

THE DAYS OF CREATION

WILLY LEY. Modern Age Books, New York, 1941. 275 pages. $2.75.

THIS book is neither religious nor philosophical, although at first glance one might be inclined to place it in either category, or both. Such might be the impression gained from the title or from thumbing through the pages, but careful reading discloses the contents as being a resume, in a popular manner, of the theories concerning the evolution of the universe and particularly of the earth and those who live on it—much after the style of Disney's treatment of the Rites of Spring, in *Fantasia*.

There are seven chapters, each preceded by a quotation from the story of creation as set forth in the Book of Genesis. The chapter headings follow the pattern of the Biblical story. The Biblical quotations are inserted for comparative purposes, and Mr. Ley says his interest was in "how closely the story of creation in Genesis and the story of evolution in the Handbook of Geology and Paleontology look alike." If you are interested in this type of approach, Mr. Ley has written the book you want.

Ideas, theories, results of experiments —all change so rapidly nowadays that each new popular science book justifies itself by including the most recent advances, but this does not apply particularly to *The Days of Creation;* and it is not necessary, for Mr. Ley's purpose, to include them. What he has done, he has done well.

R. NEWTON MAYALL
Cambridge, Mass.

NEW BOOKS RECEIVED

THE STARS IN MYTH AND FACT, *Oral E. Scott.* 1942, *Caxton.* 374 pp. $3.00.

A book for stargazers, with monthly star maps, individual constellation charts, and the text a mixture of fact and mythology.

WEATHER AND THE OCEAN OF AIR, *William H. Wenstrom.* 1942, *Houghton, Mifflin.* 484 pp. $4.50.

A well-written and comprehensive book for the layman on a subject of increasing importance to a country at war and without official weather forecasts.

THE DAYS OF CREATION, *Willy Ley.* 1941, *Modern Age.* 275 pp. $2.75.

An author of rare talent has undertaken a biography of the earth divided into "seven days of creation"—"Let There Be Light"; The Division of the Waters; The Conquest of the Land; The Great New Invention; The Triumph of the Reptiles; The Glory of the Mammals; The Consolidation of Brainpower.

HAYDEN PLANETARIUM NAVIGATION COURSES

Two introductory courses of 10 lectures each are being conducted by the Hayden Planetarium in New York City on the subjects:

I. Navigation of Air and Sea
II. Identifying the Navigation Stars

It is expected that these courses will be invaluable both to those who have had previous navigation training, and wish to take advantage of the ease with which navigation problems can be practiced in the realistic planetarium skies, and to those who want to know the fundamentals on which navigation is based.

The courses are given by Curator William H. Barton, Jr., on Tuesday and Thursday evenings from 7:30 to 8:30, and began on March 12th; course fee $2.50. All interested persons should communicate with the Hayden Planetarium, 81st Street and Central Park West, New York City.

Course I includes: Instruments of Navigation; Piloting and Sailings; Celestial and Terrestrial Spheres; Time and the Almanac; Latitude by Meridian Altitude; Line of Position; Astronomical Triangle; Observations and Corrections; Note Keeping and Tables; Air Navigation.

Course II includes: Motions of the Sky; Use of a Planisphere; Use of Charts; Use of the Almanac; Planets; Moon; Change of Latitude; Southern Sky; Star Finders; Globes.

Amateur study groups and teachers of science may find the listing of the subject matter of these courses of aid in solving their own effort to help in wartime teaching, even though they do not have the advantage of a planetarium robot to perform demonstrations for them.

ANSWERS TO DO YOU KNOW?

(*Questions on page* 5)

I. 1, b; 2, c; 3, a; 4, d; 5, d; 6, b; 7, a; 8, c; 9, c; 10, c.

II. 1, Ursa Minor; 2, Octans; 3, Coma Berenices; 4, Sculptor; 5, Draco; 6, Dorado; 7, Pisces; 8, Virgo.

III. 1, d; 2, l; 3, i; 4, k; 5, a; 6, j; 7, m; 8, e; 9, b; 10, f; 11, h; 12, c; 13, n; 14, g.

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FOR YOUR STAR-MINDED RELATIVES AND FRIENDS

If they're working overtime on defense, they might as well know how to enjoy the night sky on the way home ---

If they're potential airplane watchers, they will want to brush up on constellations and know where the planets are ---

If their hobby supplies are being cut into by priorities, let them turn to the stars—always on hand ---

If they're away at camp, they will want to keep up with astronomical happenings ---

SKY PUBLISHING CORPORATION
Harvard College Observatory
Cambridge, Mass.

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OBSERVER'S PAGE

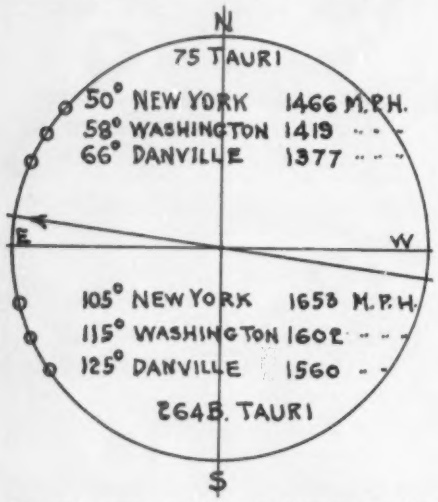
By Jesse A. Fitzpatrick

All times mentioned on the Observer's Page are Eastern War Time.

OCCULTATION TIMES

J. V. PERRY, of Danville, Va., has asked an interesting question concerning occultations of stars by the moon. On January 26th, two stars in the Hyades group, 75 and 264 B Tauri, were occulted, and in my monthly list I gave the predicted times of *immersion* at our local station, New York City, as 9:28.3 p.m. and 10:49.7 p.m. (E.S.T.), respectively. Mr. Perry timed these occultations at his location and found the immersions occurred at 9:13 and 10:52. He was curious to know why he saw one of them 15 minutes earlier and the other two minutes later than an observer in New York City. It is natural to infer that if one was timed 15 minutes earlier, the other should have been also, since the stars are relatively near each other, and the occultations a little more than an hour apart.

Danville, Va., long. 5h 17.5m west (79° 22'.5), lat. 36° 35', lies almost exactly 200 miles southwest of Washington, D. C., the same distance that New York City is northeast. I have used these three cities to illustrate the motion of the moon over



the two stars and have shown on the diagram the position angles on the east edge, measured from the north point, where each immersion was observed, and the apparent speed of the moon at the time. The latter figures are each too fast by just a trifle, because to avoid a lot of unnecessary computations, I have used the speed when the center of the moon instead of the edge passed over the star.

The following table shows the immersions at the respective cities:

	75 Tauri	*264 B Tauri*
Danville	9:13 p.m.	10:52 p.m.
Washington	9:19.8 p.m.	10:49.4 p.m.
New York	9:28.3 p.m.	10:49.7 p.m.

It is obvious from the diagram that Danville saw the immersion of the star 75 first and 264 B last, since the motion of the moon is always toward the east and at that particular time it moved about eight degrees north of east as shown by the arrow. It is also easy to see from the diagram the reason for the disappearance of 75 a quarter of an hour earlier at Danville than at New York, but the immersion of 264 B at the three stations within a space of 2.6 minutes can only be understood by a careful study of the apparent speeds of the moon at the time of each immersion.

The variation of these speeds is due to the apparent rotary speed of the earth as seen from the star. The actual speeds of the earth's rotation are 837, 811, and 789 miles per hour at Danville, Washington, and New York, respectively, and these are the speeds a man on the star would see when the star, to an observer at each of these cities, would be on the local meridian. As the man on the star followed the rotation of the city in question toward the east, this speed would gradually diminish to zero at the end of six hours. When the center of the moon is on the meridian at the same moment as the star, we may call this a geocentric conjunction. To an observer on the earth, the *apparent* speed of the moon is its actual speed (at this particular time, 2,140 miles per hour) less the speed of the observer on the earth, since the motion of both is to the east.

For the two stars in question, the longitudes of the geocentric conjunctions were exactly one hour and two hours (15° and 30°) west of Danville, the former for 75 Tauri. If the geocentric conjunction in either case had been at Danville, the apparent speed of the moon would have been 2,140 less 837, or 1,303 miles per hour. But in the case of 75, the earth had rotated 15°, and for 264 B, 30°, before there was an occultation at Danville, so the apparent rotary speeds of Danville were reduced to 763 and 580 miles per hour. This increased the moon's apparent speed to 1,377 for 75, and 1,560 for 264 B. For New York, 35° 31'.5 east of the geocentric conjunction of 264 B, the apparent rotary speed was reduced to 487 miles per hour, making the moon's apparent speed 1,653 miles per hour when the occultation was observed at this city.

The differences in the position angles of the points of immersion on the eastern edge of the moon are due primarily to latitude, but are also affected by the angle of the moon's passage north or south of due east and by the elliptical path followed by the observer's station as seen from the star. This path is almost a straight line running east and west at or near the longitude of geocentric conjunction, but as the observer's station moves eastward from this point the curvature is more pronounced.

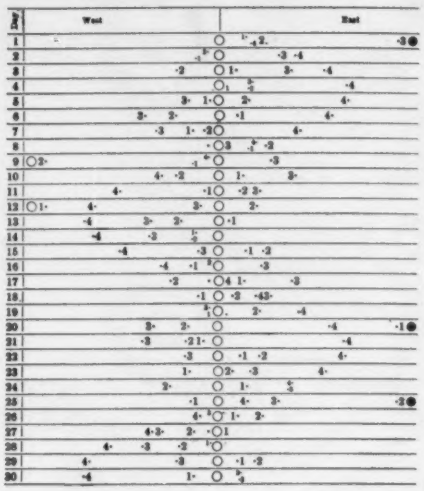
A further analysis reveals the arrival of the *center* of the moon at Danville seven minutes before it reached New York for the first occultation. It also arrived first at Danville for the occultation of 264 B, but this time by only 1.5 minutes.

PHASES OF THE MOON

Full moon	April 1, 8:32 a.m.
Last quarter	April 8, 0:43 a.m.
New moon	April 15, 10:33 a.m.
First quarter	April 23, 2:10 p.m.
Full moon	April 30, 5:59 p.m.

JUPITER'S SATELLITES

Jupiter's four bright moons have these positions at 10:45 p.m. E.W.T., on the day preceding the date shown below. The motion of each satellite is from the dot to the number designating it. Transits of satellites over Jupiter's disk are shown by open circles at the left, and eclipses and occultations by black disks at the right. From the **American Ephemeris.**



On April 13th, 26th, and 27th, the four bright moons will be on the west side of Jupiter and in numerical order, *I* being nearest the disk. On the 26th, this configuration will hold until 11:19 p.m., a few minutes before Jupiter sets in New York, and on the 27th, only after 10:42 p.m., following the transit egress of *I*.

Unfortunately, the one superior and two inferior conjunctions of *IV* in April cannot be observed in any part of the United States. The superior conjunction at 11:05.9 p.m. on May 3rd cannot be observed in the eastern part of the country, but will be visible in the middle and western sections. At the moment of conjunction, the satellite will be north of the disk and separated from it by an angular distance of two seconds. The resolving power of a telescope with at least a 4-inch aperture will be required to see this separation. This is the last of these interesting conjunctions that may be observed until 1945. In the interim, they will take place either in front of or behind the planet.

CONJUNCTIONS

A conjunction of Venus and the moon, on April 11th, will once more assist the observer in seeing the planet in full daylight. At the moment of conjunction, 1:05.2 p.m., Venus will be north of the moon's edge by a distance equal to 76.5 per cent of the moon's diameter, or an angular distance of 37'.8 from its center.

The star 90 B Cancri will be in conjunction with the moon at 10:18.5 p.m., April 23rd, when it will be 10.2 per cent of the moon's diameter north of its edge. The position angle of the moon's axis, 16 degrees, will bring this conjunction on a line from the lunar center through the crater Aristotle.

The star κ Virginis, magnitude 5.9, will be in conjunction with the moon at 0:20.8 a.m., April 29th, when it will be six per cent of the moon's diameter north of the moon's edge.

OCCULTATIONS—APRIL, 1942

Local station—lat. 40° 48′.6, long. 4h 55.8m west.

Date	*Mag.*	*Name*	*Immersion*	*P.**	*Emersion*	*P.**
April 7	var.	BD —19°5047	5:29.2 a.m.	41°	6:23.6 a.m.	320°
18	6.4	70 Tauri	9:38.1 p.m.	107°	10:32.4 p.m.	247°
28	6.2	38 Virginis	7:56.1 p.m.	150°	8:52 p.m.	258°

*P is the position angle of the point of contact on the moon's disk measured eastward from the north point.

THE PLANETS IN APRIL

Mercury is too close to the sun for observation.

Venus, in Capricornus, Aquarius, and Pisces during the month, will cross from the north to the south side of the ecliptic on April 19th at 9:00 p.m. On April 13th, it will be at greatest western elongation, 46° 19′.

Mars, in Taurus and Gemini, will be in conjunction with and 1° 44′ north of Jupiter on April 3rd. On the 27th, the planet will be about one half degree north of the star cluster M 35. The observer should use the lowest power available, 50× or less, to include Mars and this beautiful pattern of stars in the same field.

Jupiter, in Taurus, will have progressed by the end of the month to the approximate location where it started its retrograde motion on October 10, 1941. On April 18th, it will be 30 minutes north of 108 Tauri, magnitude 6.16, and on the 23rd, it will be 47 minutes north of n Tauri, magnitude 5.14. The planet will average 16 minutes south of the ecliptic through the month.

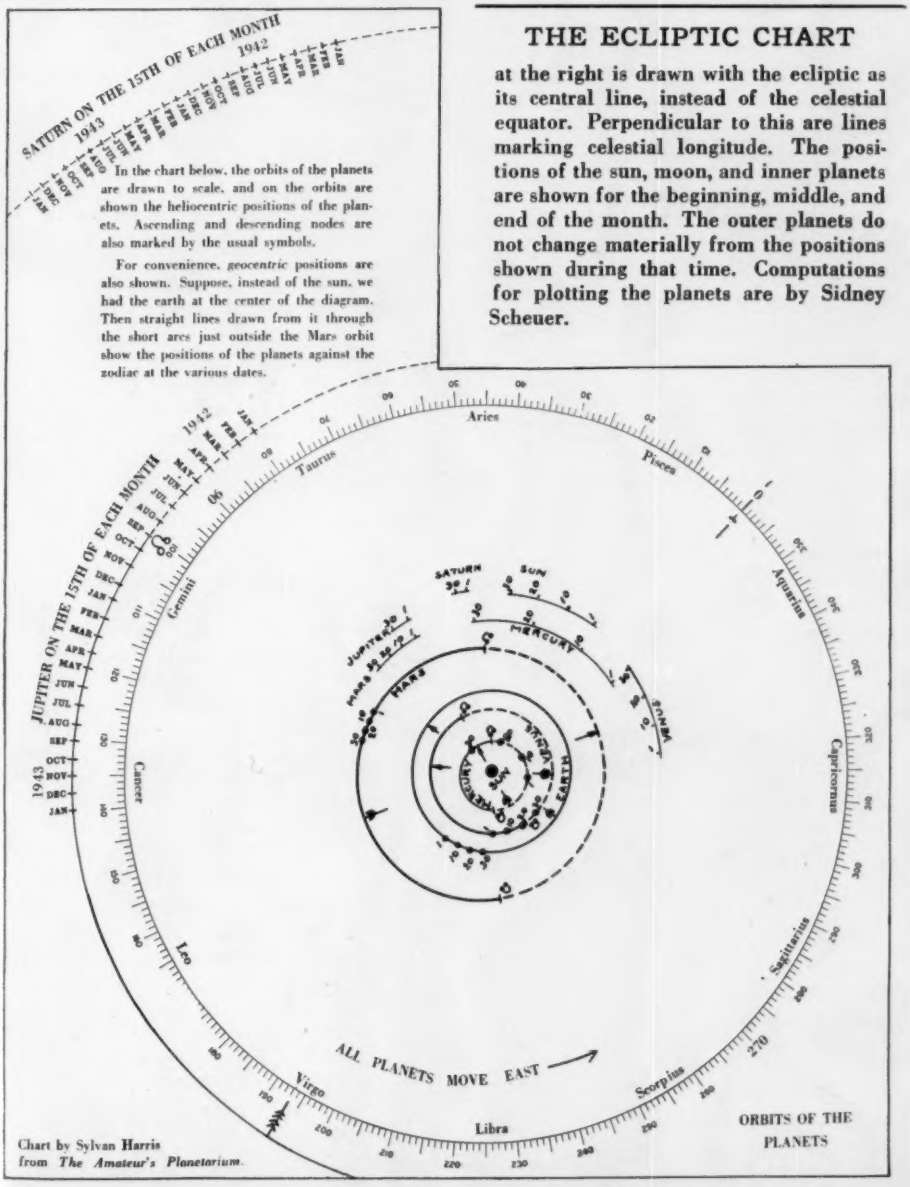
Saturn, in Taurus, will be in conjunction with and 1° 39′ south of Uranus on April 28th. On the 30th, it will be 13 minutes south of BD +18°550, magnitude 7.8.

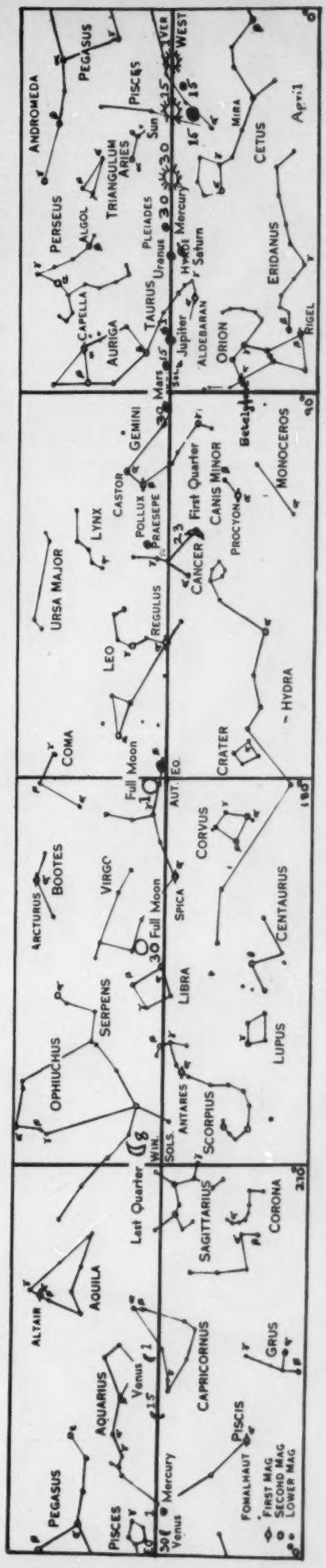
Uranus will be in Taurus.

Neptune. See diagram in the February issue. The conjunction of the planet with the moon on the 27th of the month will not be visible in the United States.

THE ECLIPTIC CHART

at the right is drawn with the ecliptic as its central line, instead of the celestial equator. Perpendicular to this are lines marking celestial longitude. The positions of the sun, moon, and inner planets are shown for the beginning, middle, and end of the month. The outer planets do not change materially from the positions shown during that time. Computations for plotting the planets are by Sidney Scheuer.


SATURN ON THE 15TH OF EACH MONTH
1942
1943
In the chart below, the orbits of the planets are drawn to scale, and on the orbits are shown the heliocentric positions of the planets. Ascending and descending nodes are also marked by the usual symbols.
For convenience, geocentric positions are also shown. Suppose, instead of the sun, we had the earth at the center of the diagram. Then straight lines drawn from it through the short arcs just outside the Mars orbit show the positions of the planets against the zodiac at the various dates.
JUPITER ON THE 15TH OF EACH MONTH
Aries
Taurus
Gemini
Cancer
Leo
Virgo
Libra
Scorpius
Sagittarius
Capricornus
Aquarius
Pisces
SATURN
SUN
MERCURY
JUPITER
MARS
VENUS
EARTH
ALL PLANETS MOVE EAST
ORBITS OF THE PLANETS
Chart by Sylvan Harris
from The Amateur's Planetarium.



THE APPARENT POSITIONS IN THE HEAVENS OF THE SUN, MOON, AND PLANETS.

THE STARRY HEAVENS IN APRIL

By Leland S. Copeland

TWO Majors, Leo and Ursa, command the heavens this month. Lion and Bear stand alert on the meridian in mid-April at 10 p.m., War Time. These star groups are reminiscent of hunting and excitement. We should like to think that in them linger memories of the cave lion and the great cave bear, twice as tall as man, but those terrors were too far back in geological time to have influenced constellation designers.

The glory that was winter is low in the west, about to disappear for half a year, and the grandeur of midsummer remains unseen below the eastern horizon.

But the heavens this month do not lack interesting objects. In the western half sparkle seven 1st-magnitude stars, while in the eastern division shine Spica and Arcturus. Regulus is on or close to the meridian. Before April 20th, Vega will be rising in the northeast to replace Rigel and Aldebaran, both of which will be nearing the western rim.

High in the east or northeast appear Virgo, Coma Berenices, and Canes Venatici, which, with Leo, are rich in vistas opening on the wonderful land of the galaxies. Amateurs should remember that the open season for galaxies begins in April.

Draco, coiling around the north pole of the ecliptic, occupies a large part of the northeast. Look for his head, a misshapen quadrangle well above the horizon, and for the tip of his tail between the bowl of the Big Dipper and the north star. Thuban, one of his suns, was pole star in the days of Egypt's glory; its mild radiance appears between the handle of the Big Dipper and the bowl of the little one.

Dying in the west are the Pleiades. Before the month ends they will have disappeared, and they will not return to the sky of this evening hour until the autumnal equinox.

SEVEN IN SILVER MIST

(Pictured on the back cover)

BECAUSE Prometheus chose for man an upright stature, human beings can look skyward and see the stars. Other animals must gaze at the ground. So runs the Grecian story.

Our ancestors once were quadrupeds, science says. After Paleolithic man had learned to stand on two feet, crooked knees and bent shoulders kept him glancing groundward. When at last he could lift his face comfortably toward the broad heavens, the Pleiades were among the objects that first compelled attention.

To unaided eyes the Pleiades are unique—a few rather bright stars in a huddle. The Hyades group is more open, and the clusters in Coma Berenices and Perseus are too dim to be conspicuous. But in the Seven Sisters earliest night watchers saw an exception, and so a mystery.

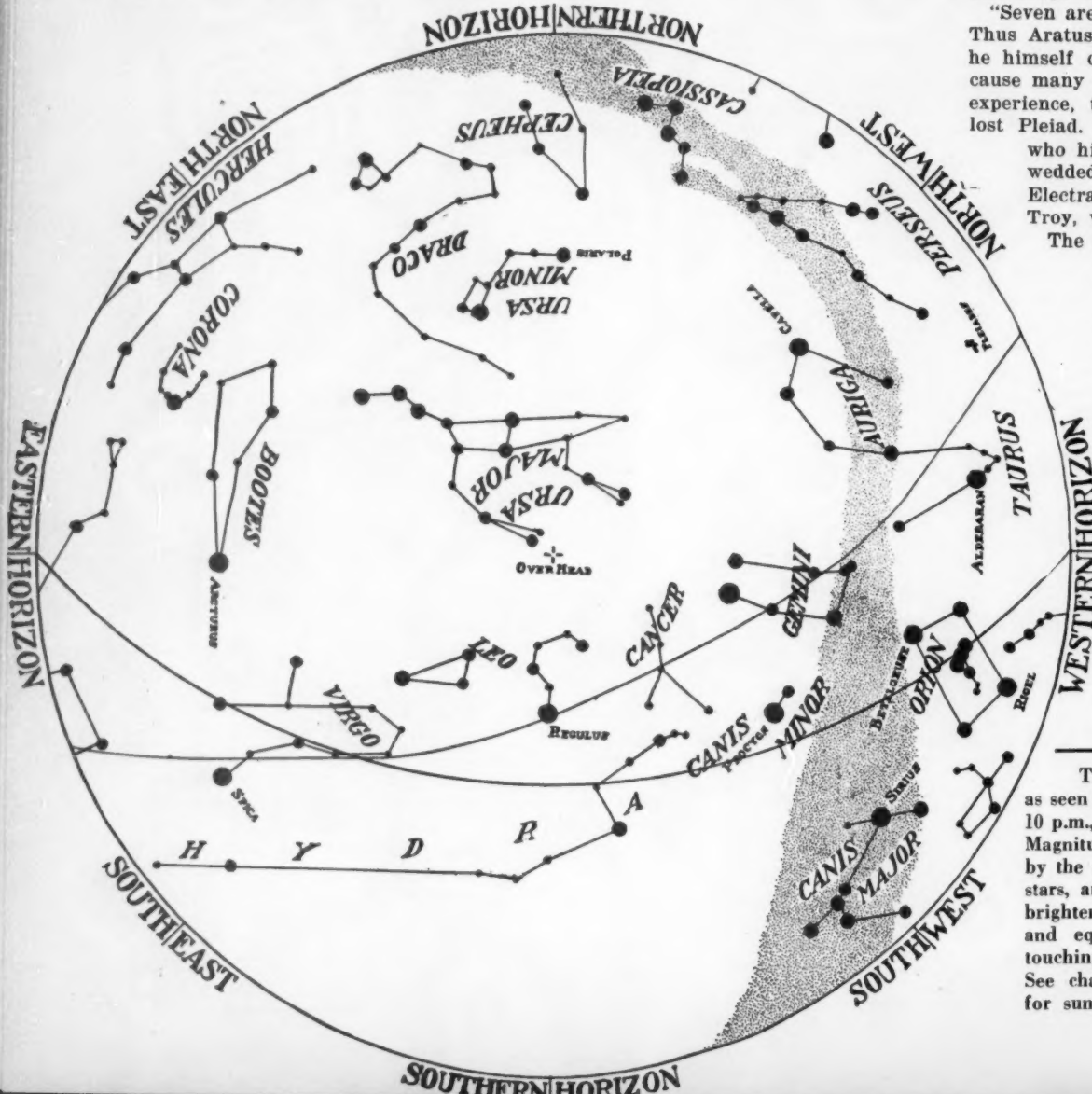
A French physician, whose hobby was archaeology, announced in 1917 that a painting of the Pleiades, made by primitive men, had been found on a cavern wall. He reported that the picture included 10 stars. This suggested that cavemen had superior vision, because there are 10 stars in the Pleiades proper. Though the physician believed that both Paleolithic and Neolithic men left evidence of their interest in this cluster, his conclusions have been accepted by few archaeologists.

If you have seen Elihu Vedder's picture of the Seven Sisters, you will agree with mythical Orion that they were beautiful. Orion, whom Homer rated as remarkably handsome, was their annoying admirer. When the giant pursued them, Jupiter changed them into doves and placed them in the heavens. Nearby are the Hyades, memorial to their half-sisters, also daughters of Atlas.

"Seven are they in the songs of men." Thus Aratus describes the Pleiades. But he himself could glimpse only six. Because many other persons had the same experience, there arose the story of a lost Pleiad. Some said it was Merope, who hid her face because she had wedded a mortal. Others mentioned Electra, overwhelmed by the fall of Troy, which her son had founded.

The cluster resembles a wee dipper. At the handle end is Atlas, with Pleione as companion. Where handle and bowl meet shines Alcyone. Alcyone, Maia, and Taygeta form the top of the bowl; Merope and Electra, the bottom. Celaeno is between Electra and Taygeta and outside of the bowl. Asterope, a double, which also is outside, is close to Maia.

A photograph shows that only six are conspicuous. Three are very dim—Pleione and Celaeno, 5th-magnitude stars, and Asterope, 6th-magnitude twins. Pleione is the girls' mother. So there are two missing sisters and three lost Pleiads.



THE STARS FOR APRIL

as seen from mid-northern latitudes at 10 p.m., April 7th; 9 p.m., April 23rd. Magnitudes of the stars are indicated by the sizes of the disks marking the stars, and the names of some of the brighter stars appear. The ecliptic and equator are shown, the latter touching the east-west horizon points. See chart on the "Observer's Page" for sun, moon, and planet positions.

HERE AND THERE WITH AMATEURS

This is not intended as a complete list of societies, but rather to serve as a guide for persons near these centers, and to provide information for traveling amateurs who may wish to visit other groups.

City	*Organization*	*Date*	*Hour*	*Season*	*Meeting Place*	*Communicate with*
BOSTON	BOND AST. CLUB	1st Thu.	8:15 p.m.	Oct.-June	Harvard Observatory	Homer D. Ricker, Harvard Observatory
"	A.T.M.s OF BOSTON	2nd Thu.	8:15 p.m.	Sept.-June	Harvard Observatory	F. I. Noyes, 340 Warren St., Brockton, Mass.
BROOKLYN, N. Y.	ASTR. DEPT., B'KLYN INST.	Round Table 3rd Thu.	8:00 p.m.	Oct.-April	Brooklyn Institute	William Henry, 154 Nassau St., N. Y. C., *BA.* 7-9473
BUFFALO	A.T.M.s & OBSERVERS	1st & 3rd Fri.	8:00 p.m.	Oct.-June	Museum of Science	J. J. Davis, Museum of Science
CHATTANOOGA	BARNARD A. S.	4th Fri.	7:30 p.m.	All year	Chattanooga Obs.	C. T. Jones, 1220 James Bldg., *CHat.* 6-8341
CHICAGO	BURNHAM A. S.	2nd & 4th Tue.	8:00 p.m.	Sept.-June	Congress Hotel	Wm. Callum, 1435 Winona Ave.
CLEVELAND	CLEVELAND A. S.	Fri.	8:00 p.m.	Sept.-June	Warner & Swasey Obs.	Mrs. Royce Parkin, The Cleveland Club
DAYTONA BEACH, FLA.	D. B. STARGAZERS	Alt. Mon.	8:00 p.m.	Nov.-June	500 S. Ridgewood Ave.	Rolland E. Stevens, 500 S. Ridgewood
DETROIT	DETROIT A. S	2nd Sun.	3:00 p.m.	Sept.-June	Wayne U., Rm. 187	E. R. Phelps, Wayne University
"	NORTHWEST A. A. S.	1st & 3rd Tue.	8:00 p.m.	Sept.-June	Redford High Sch.	A. J. Walrath, 14024 Archdale Ave.
DULUTH, MINN.	DULUTH AST. CLUB	1st & 3rd Sat.	8:00 p.m.	All year	Darling Observatory	W. S. Telford, 126 N. 33rd Ave. E.
FT. WORTH	TEX. OBSERVERS	No reg. meetings	.....			Oscar E. Monnig, 1010 Morningside Dr.
GADSDEN, ALA.	ALA. A. A.	1st Thu.	7:30 p.m.	All year	Ala. Power Auditorium	Brent L. Harrell, 1176 *W* or 55
INDIANAPOLIS	INDIANA A. A.	1st Sun.	2:00 p.m.	All year	Central Library Audit.	E. W. Johnson, 808 Peoples Bank Bldg.
JOLIET, ILL.	JOLIET A. S.	Alt. Tue.	8:00 p.m.	Oct.-May	Jol. Mus. & Art Gallery	Monica L. Price, 403 Second Ave.
LOS ANGELES	L. A. A. S.	2nd Thu.	8:15 p.m.	.....	2606 W. 8th St.	Charles Ross, 2606 W. 8th St.
LOUISVILLE, KY.	L'VILLE A. S.	3rd Tue.	8:00 p.m.	Sept.-May	Women's Bldg., Univ. of Louisville	Mary Eberhard, 3-102 Crescent Ct., *Taylor* 4157
MADISON, WIS.	MAD. A. S.	2nd Wed.	8:00 p.m.	All year	Washburn Observatory	C. M. Huffer, Univ. of Wisconsin
MILWAUKEE	MILW. A. S.	1st Thu.	8:00 p.m.	Oct.-May	Marquette U., Eng. Col.	E. A. Halbach, *Hopkins* 4748
MOLINE, ILL.	POP. AST. CLUB	2nd Tue	7:30 p.m.	All year	Sky Ridge Observatory	Carl H. Gamble, Route 1
NEW HAVEN	NEW HAVEN A. A. S.	1st Sat.	8:00 p.m.	Sept.-June	Yale Observatory	F. R. Burnham, 820 Townsend Ave., 4-2618
NEW YORK	A. A. A.	1st & 3rd Wed.	8:15 p.m.	Oct.-May	Amer. Mus. Nat. Hist.	G. V. Plachy, Hayden Plan., *EN.* 2-8500
" "	JUNIOR AST. CLUB	Alt. Sat.	8:00 p.m.	Oct.-May	Amer. Mus. Nat. Hist.	J. B. Rothschild, Hayden Plan., *EN.* 2-8500
NORWALK, CONN.	NORWALK AST. SOC.	Last Fri.	8:00 p.m.	Sept.-June	Private houses	Mrs. A. Hamilton, 4 Union Pk., 6-4297
OAKLAND, CAL.	EASTBAY A. A.	1st Sat.	8:00 p.m.	Sept.-June	Chabot Observatory	Miss H. E. Neall, 6557 Whitney St.
PHILADELPHIA	A.A. OF F.I.	3rd Fri.	8:00 p.m.	All year	The Franklin Institute	Edwin F. Bailey, *Rit.* 3050
"	RITTENHOUSE A. S.	2nd Fri.	8:00 p.m.	Oct.-May	The Franklin Institute	A. C. Schock, *Rit.* 3050
PITTSBURGH	A. A. A. OF P'BURGH	2nd Fri.	8:00 p.m.	Sept.-June	Buhl Planetarium	F. M. Garland, 1006 Davis Ave., N.S.
PONTIAC, MICH.	PONTIAC A. A. A.	2nd Mon.	8:00 p.m.	All year	Cranbrook Inst. of Sci.	J. P. Coder, 2675 Voorheis Rd., 2-9419
PORTLAND, ME.	A. S. OF MAINE	2nd Fri.	8:00 p.m.	All year	Private Homes	H. M. Harris, 27 Victory Ave., S. Portland
PROVIDENCE, R. I.	SKYSCRAPERS	1st Wed.	8:00 p.m.	All year	Wilson Hall, Brown U.	Ladd Obs., Brown U., *GA.* 3633
READING, PA.	READING-BERKS A. C.	2nd Thu.	8:00 p.m.	Sept.-June	Albright College	Mrs. F. P. Babb, 2708 Filbert Ave.
RENO, NEV.	A. S. OF NEV.	4th Wed.	.....	All year	Univ. of Nevada	G. B. Blair, University of Nevada
ROCHESTER, N. Y.	ROCH. AST. CLUB	Alt. Fri.	8:00 p.m.	Oct.-May	Eastman Bldg., Univ. of Rochester	P. W. Stevens, 1179 Lake Ave., *Glenwood* 5233-*R*
SAN ANTONIO	SAN ANT. A. A.	3rd Mon.	8:00 p.m.	All year	Le Villela	R. B. Poage, 807 Hammond Ave.
SCHENECTADY	S'TADY AST. CLUB	3rd Mon.	8:00 p.m.	All year	Observatory site	C. H. Chapman, 216 Glen Ave., Scotia
SOUTH BEND, IND.	ST. JOSEPH VAL. AST.	Last Tue.	8:00 p.m.	All year	928 Oak St.	Fannie Mae Chupp, 224 Seebirt Pl.
STAMFORD, CONN.	STAMFORD AST. SOC.	4th Wed.	8:00 p.m.	All year	Stamford Museum	Thomas Page, Stamford Mus., 300 Main St.
TACOMA, WASH.	TACOMA A. A.	1st Mon.	.....	All year	Coll. of Puget Sound	Geo. Croston, *Gar.* 4124
WASHINGTON, D. C.	NAT'L. CAP. A. A. A.	1st Sat.	8:00 p.m.	Oct.-June	U. S. Nat'l. Museum	Stephen Nagy, 104 C St., N.E., *Linc.* 9487-J
WICHITA, KANS.	WICHITA A. S.	2nd Tue.	8:00 p.m.	All year	East High Sch., Rm. 214	S. S. Whitehead, 2322 E. Douglas, 33148

Sky and Telescope is official publication of many of these societies.

★ ★

PLANETARIUM NOTES

Sky and Telescope is official bulletin of the Hayden Planetarium in New York City and of the Buhl Planetarium in Pittsburgh, Pa.

★ **THE BUHL PLANETARIUM** presents, *April 1st to 9th,* GLORY OF EASTER.

The Buhl Planetarium's Easter production graphically presents the astronomical significance of Easter—why it comes late this year, the ancient connection between Easter and the phases of the moon, the reasons for this symbolic festival occurring at different times in various years.

From *April 10th to 30th,* COLORS IN THE SKY.

Familiar as we are with the variety of colors with which nature paints the earth, most of us are not aware of the amazing wealth of color to be found in the heavens. In this sky show, Buhl Planetarium visitors see not only such things as sunsets and eclipses and the tinted northern lights, but the many startling colors concealed in stars and planets and nebulae. We find that the green and orange mottling the globe of Mars becomes pale and drab compared to the beautiful rainbows hidden in the stars themselves, which tell the astronomer such strange—but true—tales regarding the composition of stars and their motion through space.

★ **THE HAYDEN PLANETARIUM** presents, *April 1st to 12th,* SPRING FESTIVAL.

In March the sun "crosses the line" and spring begins in the northern hemisphere. From ancient time people have celebrated this season of renewed life in nature, from the rites of pagan nature worshippers, down to the present when the Passover and Easter are our spring festivals. The story with its astronomical background will be unfolded in the Planetarium sky show.

From *April 13th to May 31st,* WEATHER SIGNS IN THE SKY.

From time immemorial the sky has been scanned for weather signs. Clouds, moon, sun, rainbows, halos, and even the stars have played their part (and do yet, for that matter) in forecasting the weather. Today, with the modern science of meteorology, much of this has become lore. But despite the many superstitions that are untrue, you can read weather signs in the sky.

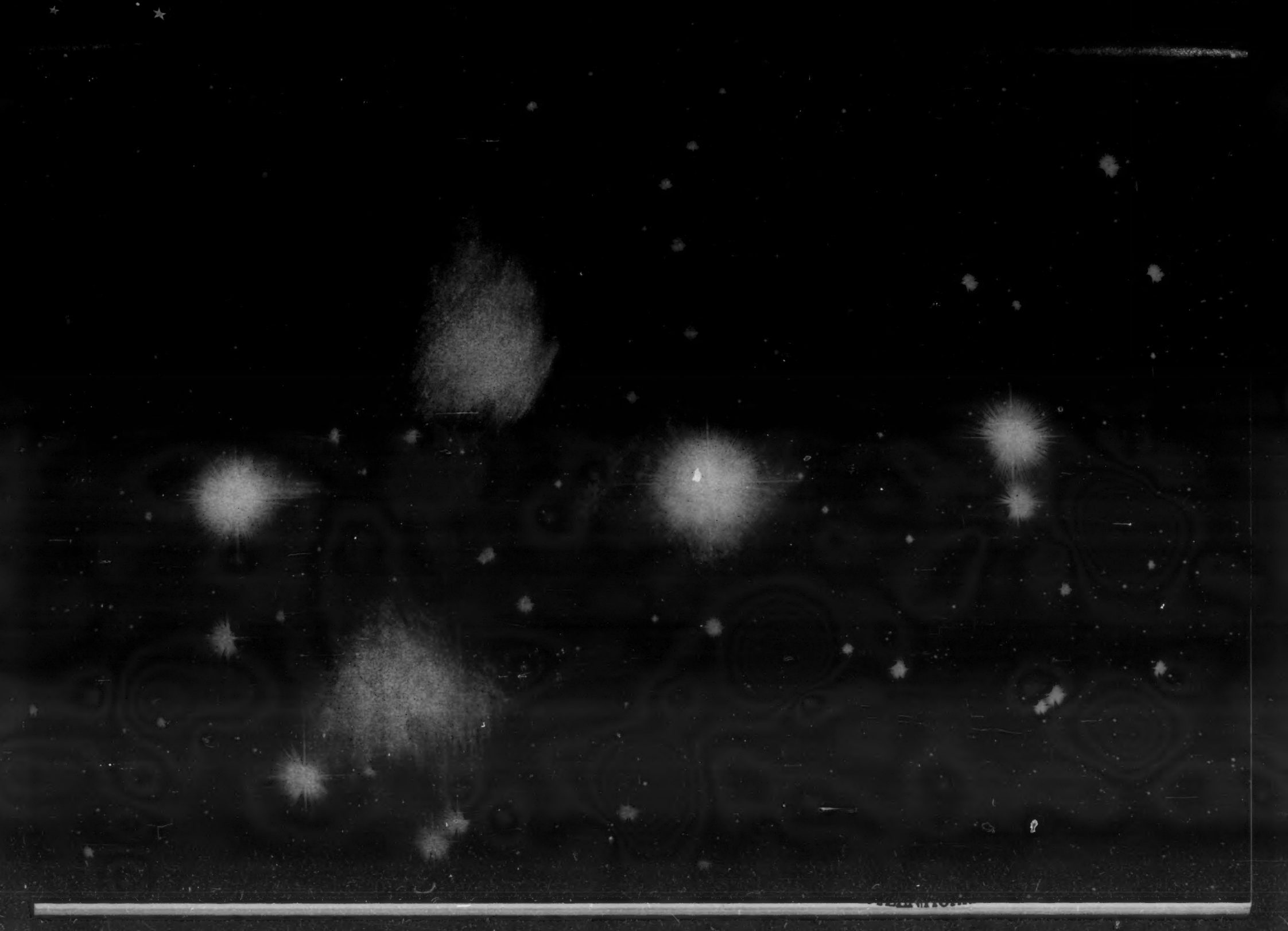
★ SCHEDULE BUHL PLANETARIUM

Mondays through Fridays ..... 3, 8, and 9 p.m.
Saturdays ..... 2, 3, 8, and 9 p.m.
Sundays and Holidays ..... 3, 4, 8, and 9 p.m.

★ STAFF—*Director,* Arthur L. Draper; *Lecturer,* Nicholas E. Wagman; *Business Manager,* Frank S. McGary; *Public Relations,* John J. Grove; *Curator of Exhibits,* Fitz-Hugh Marshall, Jr.

★ SCHEDULE HAYDEN PLANETARIUM

Mondays through Fridays ..... 2, 3:30, and 8:30 p.m.
Saturdays ..... 11 a.m., 2, 3, 4, 5, and 8:30 p.m.
Sundays—Mutual Network Broadcast—Coast-to-Coast .... 9:30-10:00 a.m.
Sundays and Holidays ..... 2, 3, 4, 5, and 8:30 p.m.

★ STAFF—*Honorary Curator,* Clyde Fisher; *Curator,* William H. Barton, Jr.; *Assistant Curators,* Marian Lockwood, Robert R. Coles; *Staff Assistant,* Fred Raiser; *Lecturers,* Alden E. Moore, Asa Tenney, John Ball, Jr.

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